NUTRIENT INTAKE AND GROWTH IN PRE-SCHOOL CHILDREN

Jessica A. Payne BSc SRD

Thesis submitted for the degree of

Doctor of Philosophy

University of Edinburgh

1991

ABSTRACT

NUTRIENT INTAKE AND GROWTH IN PRE-SCHOOL CHILDREN.

It is widely recognised that our knowledge of the nutrient intake of pre-school children aged 2 - 5 years and of their nutritional requirements for growth, is poor. Consequently, opinion is divided on whether modified diets, aimed primarily at the prevention of future adult diseases, adequately support growth in pre-school children.

Between May 1988 and April 1990 the nutrient intake and growth of 153 pre-school children from Edinburgh, aged 2 - 5 years, were assessed. 54 children repeated the study after an interval of 12 months to give a total of 207 assessments. Nutrient intake was determined by the 7 day weighed inventory method. Anthropometric measurements included height, weight and skinfold thicknesses. Supplementary information and social details were recorded by questionnaire. The data was grouped and analysed by age and gender of the children, and also by socioeconomic group.

For each group of children a low mean energy intake of 80% - 85% of the current UK Estimated Average Requirement of energy was found (Department of Health 1991). The intake of other nutrients ranged widely, with group mean intakes at or above values of Recommended Nutrient Intakes, except for the intake of vitamin D which was very low and of iron in 2 year old children which was also low.

The % of energy from fat, sugar, starch and dextrin varied considerably but no correlations were found with energy intake. Thus low fat or high sugar diets did not affect the average daily intake of energy. Such diets, however, did significantly affect the quality of the diet in terms of mineral and vitamin intakes per 1000 kilocalories. Also, highly significant correlations were found between intake of nutrients during the first and second survey of children studied twice.

The anthropometric measurements of the children ranged widely but fell within the normal range for age, with group mean values for height and weight at or above the 50th percentile level. As anticipated, highly significant positive correlations were found between age, height, weight and energy intake. However, no significant correlations were found between energy or nutrient intakes and rate of growth, in terms of height velocity.

The nutrient intake and growth parameters of children taking low fibre v high fibre and low fat v high fat diets were compared. No evidence was found to suggest that modification of diet compromised the normal growth of pre-school children. Likewise, no evidence was found to suggest that children who had been taking semi-skimmed milk for the previous year were growing less well than those taking full-fat milk.

A full discussion of the results of this thesis is given and dietary guidelines for pre-school children aged 2 - 5 years are proposed.

TABLE OF CONTENTS.

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AHA	American Heart Association
a-T-eq.	alpha tocopherol equivalents
BDA	British Dietetic Association
BHF	British Heart Foundation
BMI	body mass index
BMR	basal metabolic rate
BNF	British Nutrition Foundation
CHD	coronary heart disease
CHO	carbohydrate
circ.	circumference
COMA	Committee on Medical Aspects of Food Policy
CPG	Coronary Prevention Group
DEI	daily energy intake
DHSS	Department of Health and Social Security
DLW	Doubly Labelled Water Technique
DOH	Department of Health
DRV	dietary reference value
EAR	estimated average requirement
excl.	excluding
F	female
fort.	fortnightly
FRED	Food Recording Electronic Device
g	gram
G.P.	General Practitioner
HDL	high density lipoprotein
HEC	Health Education Council
HF	high fat diet
ht	height
H.V.	Health Visitor
IgE	immunoglobulin E
IIIm	socioeconomic group III manual
IIInm	socioeconomic group III non-manual
incl.	including
jce	juice (eg fruit juice)
kcal	kilocalorie
kg	kilogram
kJ	kilojoule
LDL	low density lipoprotein
LF	low fat diet
LRNI	lower reference nutrient intake
M	male
MAFF	Ministry of Agriculture Fisheries and Food
max	maximum
mcg	microgram
mg	milligram
min	minimum
MRC	Medical Research Council
MUFA	monounsaturated fatty acid
NACNE	National Advisory Committee on Nutrition Education
NCHS	National Centre for Health Statistics
Nether.	Netherlands

Abbreviations (continued)

Nicot. acid	nicotinic acid
NNDB	Nuffield Nutrition Database
NSP	non-starch polysaccharide
25-OHD	25 - hydroxy vitamin D
OPCS	Office of Population Censuses and Surveys
PETRA	Portable Electronic Tape Recording Device
pop.	population
pot.	potato
prod.	product (eg meat product)
P:S ratio	polyunsaturated fat : saturated fat ratio
Publ^{N}	publication
PUFA	polyunsaturated fatty acid
RDA	recommended daily amount
ref.	reference
ret. eq.	retinol equivalents
RMR	resting metabolic rate
RNI	reference nutrient intake
SD	standard deviation
SDA	Seven Day Adventist
SDS	standard deviation score
SFA	saturated fatty acid
s'fold	skinfold
signif.	significance
spr.	spread (eg low fat spread)
sub-scap.	sub-scapular
TDEE	total daily energy expenditure
UK	United Kingdom
USA	United States of America
vel.	velocity
vit.	vitamin
VLDL	very low density lipoprotein
WHO	World Health Organisation
wks	weeks
wt	weight
yrs	years

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude for the support, advice and encouragement of the following people:

In particular **Dr. N.R. Belton**, Senior Lecturer, Department of Child Life and Health, University of Edinburgh, for the enthusiastic encouragement that instigated this research and provided support throughout the four year research period, and for his constructive advice as supervisor.

My husband, **Dr. Andrew Payne**, for his tolerance, encouragement and invaluable support in computing.

Mr. T.R. Kirk, Lecturer in Nutrition, Queen Margaret College, Edinburgh, for his much valued academic advice and supervision; and for his support and encouragement in instigating this research.

Professor N. McIntosh, Head of Department, Child Life and Health, University of Edinburgh, for welcoming me into his department and for the provision of accommodation and facilities.

Dr. R.A. Elton, Senior Lecturer, Department of Medical Statistics, University of Edinburgh, for his advice on the design of this study and on the statistical analysis of data.

Dr. C.J.H. Kelnar, Consultant Paediatric Endocrinologist, Royal Hospital for Sick Children, Edinburgh, for his advice on taking and interpreting anthropometric measurements.

Mrs J. Calder, Research Dietitian, formerlly Dept. Child Life and Health, University of Edinburgh, for her advice on undertaking a weighed dietary survey and on formulating the instructions for mothers.

I would also sincerely like to thank the following people for their contribution to this research:

Warmest gratitude to **the parents** (usually mothers) who worked so diligently to record their childrens food intake, and for their inspiring interest in the outcome of this research.

The children, for their patience, cooperation, and for making the collection of data such a pleasant and enjoyable period.

Mrs Jan Arthur, computing department of Lothian Health Board, for the provision of lists of children from the Lothian Child Health Register.

The Department of Child Life and Health, University of Edinburgh, especially **Mrs Rhona Steven** for her unofficial role as 'counsellor' in times of stress.

I would like to thank the following organisations for their financial support:

The British Heart Foundation for the provision of a PhD studentship and half payment of University fees.

The Nutritional Consultative Panel of the National Dairy Council for the purchase of equipment and for travelling expenses.

The Carnegie Trust for the Universities of Scotland for half payment of University fees.

Milupa for assistance in the purchase of stationery.

DECLARATION

Except where assistance and advice has been duly acknowledged, the research described in this thesis has been entirely undertaken by myself and the entire thesis composed by myself.

Jessica A. Payne BSc SRD
August 1991.

CHAPTER 1 INTRODUCTION

At the beginning of the twentieth century many paediatricians turned their attention to the assessment and determinants of growth in early childhood. Paton and Findlay (1926) in a Medical Research Council study of "Poverty, Nutrition and Growth in Scotland," stated 'there seems little doubt that the best assessment of growth in a homogeneous race is height for age', a sentiment that can be upheld today. However, as regards the relationship between nutrition and growth, they said:

> "Nutrition does not refer to the height of the child, to the state of his health, or to his muscular activity. Nor has nutrition anything to do with growth. Nutrition simply refers to the manner in which an individual absorbs and assimilates his food, in short, increases his bulk."

"Nutrition" was thus assessed in terms of 'weight for height', without reference to diet.

Despite an apparent scepticism in the medical profession of a relationship between diet, health and growth, worldwide dietary surveys undertaken during the 1920's were pioneering the science of "nutrition" as it is today accepted in its' broader sense.

Today we recognise that our diet from early childhood not only influences our physical development and tendency towards nutritional deficiency diseases, now rare, but also influences our predisposition to diseases of affluence such as heart disease, cancer and obesity.

DIETARY SURVEYS OF BRITISH PRE-SCHOOL CHILDREN.

The earliest dietary survey of significance of British children was undertaken between 1935 - 1939 by Widdowson, though due to the intervention of World War II it was not published until 1947 (Widdowson 1947). This cross-sectional survey studied the diet and anthropometric status of over 1000 children aged one to eighteen years, who were largely from middle-class homes in the London area. Food intake was assessed by the 7-day weighed in-take method, setting a precedent and standard for the vast majority of UK dietary surveys undertaken since. Anthropometric status was measured by height and weight (Table 1).

Widdowson found large variations in calorie and nutrient intake from one child to another, whether grouped according to age, weight, height or surface area. This she could not explain but concluded that a wide variation in individual calorie and nutrient intake was compatible with good health and development.

Of interest is Widdowson's finding that the percent-age of energy derived from fat and carbohydrate was the same at one year of age, during the pre-school and school years, and until 18 years of age (table 1).

TABLE 1

COMPARISON OF ENERGY INTAKE, AND SOURCES OF ENERGY,

IN PREVIOUS STUDIES OF BRITISH PRE-SCHOOL CHILDREN.

AGE 2 YEARS

REFERENCE	(i)	(ii)	(iv)	(v)
YEAR OF STUDY	1937	1951	1968	1984
MEAN AGE (months)	28	n/a	24	24
NUMBER (M + F)	44	92	394	30
ENERGY (Kcal)	1419	1540	1267	1034
(Kcal/kg)	102	n/a	101	n/a
% energy FAT	37	40	39	n/a
% energy CHO	51	48	49	n/a
% energy PROTEIN	12	12	12	n/a

AGE 3 YEARS

REFERENCE	(i)	(ii)	(iii)	(iv)	(v)
YEAR OF STUDY	1937	1951	1968	1968	1984
NUMBER (M + F)	41	92	83	407	39
MEAN AGE (months)	43	n/a	37	36	36
ENERGY (Kcal)	1612	1590	1392	1406	1159
(Kcal/kg)	102	n/a	n/a	98	n/a
% energy FAT	38	40	40	38	39
% energy CHO	50	48	48	51	49
% energy PROTEIN	12	12	12	12	12

AGE 4 YEARS

REFERENCE	(i)	(ii)	(iv)
YEAR OF STUDY	1937	1951	1968
MEAN AGE (months)	55	n/a	48
NUMBER (M + F)	43	92	319
ENERGY (kcal)	1828	1730	1475
(Kcal/Kg)	99	n/a	90
% energy FAT	38	40	38
% energy CHO	51	48	51
% energy PROTEIN	12	12	11

REFERENCES

(i) Widdowson E. M. (1947)
(ii) Bransby and Fothergill (1954)
(iii) Black et al. (1976)
(iv) DHSS (1975)
(v) Black and Paul (1987)

Worldwide studies of school-children in the 1920's showed wide variation in the relative proportion of fat and carbohydrate in their diets, a reflection of custom and habit. Children from the U.S.A., Finland and Scotland obtained 34%, 15% and 30% of energy from fat respectively (Widdowson 1947). Widdowson also found that children of unemployed families were generally below average in height and weight. They ate more bread and less milk and meat.

With a particular interest in vitamin C intake, Bransby and Fothergill (1954) studied the diet of 461 pre-school children in April 1951. Though based on the methodology of Widdowson, no anthropometric measurements were taken, nor was the nutrient intake of boys and girls reported separately. The mean daily intake of energy suggests a slightly higher intake at 2 years and a slightly lower intake at 4 years compared to the figures of Widdowson. They found lower intakes of vitamin C than Widdowson (1947). In both studies vitamin C was derived mainly from citrus fruit.

Between 1967 - 1968 two further studies of pre-school children were undertaken (Black et al. 1976, DHSS 1975). In an intensive semi-longitudinal survey in Newcastle-Upon-Tyne, Black et al. (1976) monitored the diet and growth of 140 children aged 8 months, 20 months, 3 years and 5 years, giving a total of 214 completed surveys. The results (table 1) for 3 and 5 year old children indicated a calorie intake 10 - 15% lower than found in previous studies. The average intake of vitamins and minerals was mostly well above recommended daily intakes with iron intake just adequate and vitamin D intake low (Black et al. 1976).

Black et al. found no significant difference in body weight or rate of weight gain between the sexes or social class groups at any age. Total energy intake (NOT per Kg.) was significantly correlated with weight. Curiously, they only related dietary data to rate of weight gain, not height. It was concluded that in healthy young children energy intake is associated with rate of weight gain, but cannot be related to adequacy of diet for growth without information on body composition or energy expenditure.

The results of a larger cross-sectional DHSS survey carried out between 1967 and 1968 generally mirrors the findings of Black et al., with very similar mean figures for energy and nutrient intakes (Table 1). This survey looked carefully at the relationship between milk intake and growth. Though some children drank very little milk there was no significant effect on height or weight.

The DHSS survey of 1967 - 1968 gave extensive information on the food sources of nutrients. Milk and milk products and bread and cereal products were found to be the principal sources of energy, protein, fat, carbohydrate and calcium.

The four surveys described have two findings in common:

(i) Children of social class IV and V had higher energy intakes, and a higher consumption of bread and flour products. The children were not heavier.

(ii) There was a wide variation in individual energy and nutrient intakes, in both sexes and at each age.

One remaining study completes our review of previous studies on the nutritional intake and growth of British pre-school children. Two sources, Department of Health (1989a) and the National Dairy Council (1987) give results of a small unpublished survey of pre-school children carried out in 1984 by Black and Paul (table 1). This survey found mean energy intakes for 2 and 3 year old children to be substantially lower, by 15%, than found by Black et al. (1976) and DHSS (1975).

The above surveys provide useful and interesting information on the nutrient intake, dietary patterns and anthropometric status of pre-school children over the past 50 years. However, the diet of children today is quite different from that of 50 or even 20 years ago, due to a higher consumption of convenience foods and easier access to a wider range of foreign foods. Today we also have a better knowledge of nutrition and of the nutritional content of foods.

Until recently the Recommended Daily Amounts of energy for pre-school children were based on the finding of the preceding studies (DHSS 1979). Whilst up-to-date information on energy intake is lacking, recent estimates of energy expenditure in pre-school children suggest that energy requirements are today much lower than previous estimates of energy intake (Prentice et al. 1988, Davies et al. 1991, Livingstone et al. 1991). The latest Estimated Average Requirements of energy for pre-school children to be issued by the Department of Health are a compromise between previous estimates of energy intake by diet survey methodology and recent estimates of energy expenditure by the doubly labelled water method (c.f. Validation of diet survey methodology) (DOH 1991).

In addition to looking at total nutrient intake, we are now also interested in looking at how the composition of the diet in relation to the ratio of energy obtained from fat, carbohydrate and protein affects nutrient intake and growth. This is an aspect rarely alluded to in previous studies. Also, previous studies provided little information on cholesterol and fatty acid intake, or sugar and starch intake as distinct from total carbohydrate intake (DOH 1991). At present there are no dietary reference values for fibre intake in pre-school children, partly because there are no published figures for fibre intake on which to base a value and partly because there are no data on the physiological effect of fibre in children (DOH 1991).

Growth is examined in terms of absolute height and weight in the above surveys. There is no information on height velocity, thus the dietary information itself cannot be assessed on its adequacy for growth.

Worldwide it is popular to assess a child's anthropometric status using mid-calf and mid-arm circumferences, as a measurement of muscle mass. Readings of triceps and subscapular skinfold thicknesses also provide useful information on body composition. These measurements were not taken in the preceding dietary surveys of pre-school children.

In conclusion, previous nutritional surveys of pre-school children provide useful information with which to compare the diet and growth of children today. They cannot be used as an indication of whether the nutritional intake of today's generation of pre-school children is appropriate, nor do they provide scientific data on the adequacy of diet for growth, in relation to growth velocity.

NON-UK DIETARY STUDIES OF PRE-SCHOOL CHILDREN.

Outwith Britain it is also recognised that there is a need for more information on the nutritional intake of pre-school children and on the relationship of diet with growth.

TABLE 2

COMPARISON OF ENERGY INTAKE, AND SOURCES OF ENERGY, IN RECENT NON-UK STUDIES OF PRE-SCHOOL CHILDREN.

AGE 2 YEARS

REFERENCE	(b)	(c)	(d)
YEAR OF PUBL^N	1986	1986	1987
COUNTRY	Sweden	Nether.	USA
MEAN AGE (months)	n/a	28	n/a
NUMBER (M + F)	92	124	n/a
ENERGY (Kcal)	1356	1130	1813
Kcal/kg	n/a	82	n/a
% energy FAT	36	34	39
% energy CHO	50	51	49
% energy PROTEIN	14	15	12

AGE 3 YEARS.

REFERENCE	(d)	(e)
YEAR OF PUBL^N	1987	1990
COUNTRY	USA	Italy
MEAN AGE (months)	n/a	36
NUMBER (M + F)	n/a	148
ENERGY (Kcal)	2000	1357
Kcal/kg	n/a	86
% energy FAT	36	38
% energy CHO	53	46
% energy PROTEIN	12	15

AGE 4 YEARS.

REFERENCE	(a)	(b)	(d)
YEAR OF PUBL^N	1984	1986	1987
COUNTRY	Australia	Sweden	USA
MEAN AGE (months)	54	n/a	n/a
NUMBER (M + F)	183	332	n/a
ENERGY (Kcal)	1354	1595	2128
Kcal/kg	76	n/a	n/a
% energy FAT	35	36	38
% energy CHO	51	50	51
% energy PROTEIN	14	14	13

REFERENCES

(a) Magarey and Boulton (1984), Australia: 3 day weighed intake.
(b) Hagman et al. (1986), Sweden: 7 day diary - household meas.
(c) Hoffman et al. (1986), The Leiden Pre-school Study, Netherlands: 24 hour recall.
(d) Nicklas et al (1987), The Bogalusa Heart Study, U.S.A.: 24 hour recall.
(e) Franscescato et al (1990), Italy: 7 day diary - standard food portions.

During the past decade several studies have been published, providing useful comparative data. However, as eating patterns, activity levels, climate and methodology differ from one country to another we should not directly extrapolate nutritional information from one country to another. The results of nutrient intake from these surveys are outlined in table 2.

It is pertinent to note that outwith Britain the methodology of choice is not a 7-day weighed intake, possibly because of the demand it places on both the researcher and subject. Accuracy of methodology undoubtedly influences the study results (Marr 1971, Bingham 1987).

Of particular importance is an Australian study of 183 4 year old children by Magarey and Boulton (1984), undertaken in 1980 and forming part of a longitudinal study from birth. Energy and nutrient intake, including that of fibre, fatty acids and total sugar intake was assessed using a 3-day weighed intake. This is the only known survey providing data on fibre and fatty acid intake in pre-school children. Height, weight and skinfold thicknesses were taken.

Magarey and Boulton (1984) found the energy and nutrient intake of their cohort of children to be lower than previously found in most worldwide studies and suggest these differences may reflect a lower level of activity than in previous decades, subtle influences of climate, and/or a contribution from methodological differences.

In 1986 the results of two surveys were published, a Swedish study by Hagman et al., using a 7-day diary (household measures), and The Leiden Pre-school Study from the Netherlands by Hoffmans et al., based on the 24-hour recall method (table 2).

Hagman et al. (1986), found levels of energy and micronutrient intakes for 2 and 4 year old children comparable with previous UK dietary surveys. Studying children between 2 and 13 years of age, they also noted that nutrient density changed little with age, echoing the finding of Widdowson (1947). However, compared to the UK studies, contribution of fat to energy intake was consistently lower, an observation in common with other non-UK studies.

Hoffmans et al. (1986) carried out a longitudinal study of 124 children of 4, 16 and 28 months using the 24 hour recall method. Energy intake was low (table 2) in comparison to recommended intakes, giving rise to the conclusion that recommended intakes of energy for the Netherlands need to be revised.

The Bogalusa Heart Study in the USA recorded the dietary intake of a large cohort of pre-school children using similar methodology to Hoffmans et al., but found very different results (table 2)(Nicklas et al. 1987). At 2, 3 and 4 years of age the mean energy intake of the children was exceptionally high, 42% higher at 4 years for girls compared to a previous study from the north central region of the United States (Eppright et al 1972) and as high as in 10 year old Bogalusa children (Nicklas et al. 1987). Nicklas et al. suggested that the difference could reflect a recent tendency to overfeed young children.

Finally, a recently reported semi-longitudinal Italian study of children aged 8 months, 18 months and 36 months (Francescato et al. 1990), using a 7 day non-weighed diary, found similar energy intake at 36 months as Black et al. (1976) and the DHSS (1975). The Italian children have a higher intake of protein, taking 15% of energy as protein in comparison to a UK average of 12% energy from protein.

These studies provide important information about the nutritional intake of pre-school children in other industrialised countries. However, even though many are of a longitudinal nature, no information is provided relating dietary intake, or the composition of the diet, to velocity of growth.

An Australian study by Boulton (1981) has examined the relationship between energy intake, type of diet (breast, formula and weaning) and growth velocity in a cohort of infants age 0 - 24 months. He found few correlations, except at 6 - 12 months when infants in the lowest quintile of energy intake had the greatest mean height velocity. He concludes that although quantitative and qualitative differences in nutrient intake may be associated with minor and subtle differences in growth patterns during the first 6 months of life, they do not persist beyond infancy, perhaps through genetic differences in metabolic rate then being expressed.

NUTRITIONAL SURVEYS OF SCHOOLCHILDREN AND ADULTS.

The longest standing survey of the British household diet is the annual National Food Survey. Since 1940 food purchases in one week of over 8000 households have been recorded each year. This does not take account of food wastage, the distribution of food consumption within the home, nor food eaten outwith the home. Neverthless, it has allowed us to monitor trends in food consumption and preferences over the years, a useful source of information for nutrition educators and the food industry.

Over the past fifty years more detailed nutritional studies of schoolchildren and adults have monitored trends in nutrient intake, growth and eating habits. Two recent surveys are of particular relevance as they provide up to date dietary information for comparison with that of our pre-school children (DOH 1989b, OPCS 1990).

In 1989 the Department of Health published 'The Diets of British Schoolchildren', a diet and anthropometric survey of over 3000 children aged 10/11 and 14/15 years, undertaken during 1982/1983. The cohort included 884 10/11 year old Scottish children. Diet was recorded by 7-day weighed intake; growth was assessed by height and weight.

The dietary assessment found the mean energy intake of groups of children to be approximately 90% of the 1979 DHSS Recommended Daily Amount (RDA) of energy. The main sources of energy, in descending order, were bread, chips, milk, biscuits, meat products and cakes, which together accounted for about half of energy intake. Fat intake averaged 37-39% of energy intake, with 25% of subjects taking over 40% energy from fat. The main sources of fat were milk, chips, meat products, biscuits, red meat, crisps and butter, together accounting for over half of fat intake. The younger children derived 4% of energy from milk fat. Mean protein intake was 11.8 - 12.4% of energy intake. Total carbohydrate intake averaged 49 - 51% of energy intake. This survey was unable to estimate the intake of dietary fibre or sugar as insufficient information was available to construct an adequate nutrient database. The group mean vitamin and mineral intakes were generally above the RDA levels (except iron and vitamin D).

Analysis of anthropometric measurements found mean values for nearly all groups of children above the 50th percentiles for height and weight, suggesting no evidence of malnutrition.

In previous studies, social class differences in height were found to be established by 2.5 years and persisted among primary children until 5 - 11 years. The reasons were not fully understood (DOH 1989b).

In this study there were few statistically significant differences in height across the socioeconomic spectrum. The 10/11 year old children of unemployed fathers were signifiantly shorter than those of fathers in employment. There was also a tendency for the older boys of groups IV and V to be shorter.

The 10/11 year old boys of social class I and II had a significantly higher energy intake than groups IV and V, though not higher than children of unemployed fathers. There were no other statistically significant differences in energy or nutrient intake for boys or girls of any age, though intake of vitamins and minerals did tend to fall with descending social class.

Small regional differences in nutrient intakes were found. The mean energy and fat intakes of Scottish children were not significantly different from other regions. Scottish children however, on average consumed lower intakes of vitamins, especially vitamin C, carotene and retinol due to a lower intake of carrots and vegetables. There were no significant regional differences in height or weight.

An examination of the anthropometric data in relation to family size found no relationship between height and the number of siblings in 2 parent families. There were no differences between the height of children from 2 and 1 parent families. No consistent relationship was found between family size or number of parents and the energy and nutrient intake in any group of children.

The second recent survey of interest is 'The Dietary and Nutritional Survey of British Adults', undertaken by the Office of Population Censuses and Surveys (OPCS 1990). This is the first national dietary survey of British adults. Between October 1986 and August 1987 2197 adults aged 16 to 64 completed a 7 day weighed diet record.

For both men and women the recorded mean energy intake was low, at approximately 87% and 78% of the 1979 DHSS RDA values for energy, respectively. For men, mean intake of fat was 37.6% of energy (40.4% excluding alcohol), and for women 39.2% of energy (40.3% excluding alcohol). For both men and women total sugar intake provided 19% of non-alcohol energy. The average fibre intake was 25g for men (10.3g/1000 Kcal) and 19g (11.2g/1000 kcal) for women. In relation to energy intake the mean protein intakes were high at 14% of total energy intake for men and 15% for women. Average vitamin and mineral intakes were above the 1979 DHSS RDA values.

Age, regional, socioeconomic and gender variations in nutrient intake were thoroughly examined. The energy intake of men varied significantly with region, economic status and social class. There were lower energy intakes in socioeconomic group III non-manual, those in receipt of benefit and those living in Scotland. Among women energy intake varied significantly with social class, age and economic status. Women in social class I and II had the highest energy intakes. Those in households receiving benefits had a significantly lower energy intake.

Intake of protein, sugar and fibre had a strong positive correlation with energy intake for both men and women, accounting for much of the variation in intake of these nutrients. Allowing for differences in energy intake, sugar and fibre intake in men varied significantly by region and social class. Sugar intake was lower in Scotland, Northern England and in the manual social classes. Fibre intake, per unit energy, was lowest in Scottish men, London and the South East, but was higher for social classes I and II.

The sugar intake of women tended to be higher in social class I and II, and younger women had a significantly higher intake of sugar than older women. The dietary fibre content of women's diets was significantly related to age and social class, intakes being higher in older women and in social classes I and II. Vitamin and mineral intakes in women were lower in households receiving benefits.

The percentage of food energy (excluding alcohol) from fat was similar for men and women across all age groups. For both men and women there was a strong positive correlation of 0.9 between energy intake and total fat intake.

In men fat intake was significantly related to 'economic status' (as distinct from social class) and region, with those living in London and the South East having relatively high fat intakes. Those not working or in receipt of benefits had a relatively low fat intake, both in terms of total weight of fat and percentage of food energy from fat. Men in employment and those from London, the South East and Scotland obtained a higher percentage of food energy from saturated fatty acids (SFA). However, the percentage of both total energy and food energy provided by fat and by saturated fatty acids did not differ significantly according to social class. Older men and those in social class IV and V had significantly lower ratios of polyunsaturated fat: saturated fat (P:S ratios) in their diets.

In women energy intake and total fat intake were related to social class, with those in social class I and II having higher total fat and total energy intakes, whilst those in receipt of benefits had a lower total fat and total energy intake. However, expressing fat intake as a percentage of food energy there was no significant variation with either age, regional or economic variables, or with social class.

Thus for both sexes the percentage of total energy or food energy (non-alcohol) derived from fat was not significantly related to social class.

Nutrient intake was examined in relation to the UK dietary recommendations of DHSS (COMA) 1984.

Only 12% of men and 15% of women had fat intakes meeting the COMA target of 35% food energy. Only 11% of men and 12% of women derived less than the COMA target of

15% of energy from SFA and trans fatty acids. Only 6% of men and 8% of women met both targets. The main sources of fat were meat and meat dishes (24%), cereal products (19%), fat spreads (16%), and milk and milk products (15%).

The main sources of carbohydrates were cereal products (46%), vegetables (16%), sugar, confectionery and preserves (13%). Almost 50% of fibre came from cereal products, 17% from wholemeal and brown bread, 13% white bread and 38% from vegetables (potato 12%).

Analysis of height data revealed social class groups I and II to be significantly taller than IV and V for both men and women.

The Dietary and Nutritional Survey of British Adults also analysed blood for total serum cholesterol and high density lipoptotein (HDL) cholesterol; low density lipoprotein (LDL) cholesterol was estimated by difference. Height and weight were taken from which body mass index (BMI) was calculated. Current medical opinion regards a high serum level of HDL cholesterol as protective of CHD, whilst raised LDL or total serum cholesterol levels are "risk factors" for CHD.

Intake of cholesterol, percentage of energy from SFA and BMI all had significant positive associations with total serum cholesterol for both men and women.

For either sex there was no significant association between total serum cholesterol or HDL cholesterol concentration and region, social class or economic status.

There was no association between total serum cholesterol concentration and smoking. Those who smoked or had a high BMI tended to have a lower HDL cholesterol concentration.

For both men and women there was a significant positive correlation with HDL cholesterol concentration and percentage of energy from fat. Alcohol also tended to raise HDL cholesterol concentration.

In conclusion, both of the above recent surveys found few significant differences in nutrient intake in relation to age, region or socioeconomic status. For both children and adults there was a tendency for lower energy and nutrient intakes in social classes IV and V and the unemployed, with these groups tending also to be slightly shorter.

DIETARY GUIDELINES.

The relationships between nutrition and diseases of overnutrition such as coronary heart disease, obesity and cancer, are complex and highly controversial. Strong epidemiological evidence links a typical western diet, that is high in fat with such diseases (NACNE 1983, DHSS (COMA) 1984, DOH 1991). Three decades of nutritional research have failed to clarify the magnitude of the dietary "risks" involved, yet the concensus of medical opinion in developed countries is in favour of imparting nutritional advice aimed at reducing the incidence of disease, particularly heart disease. During the past decade health education in the UK has placed great emphasis on dietary guidelines for disease prevention.

The concept of dietary guidelines was introduced by Sweden in 1968. Successive generations of dietary recommendations in a wide variety of western countries bear a strong resemblance to the original Swedish values. However, it was the wide publicity surrounding the release of the McGovern Goals of the United States in 1977 that brought the subject of dietary guidelines to the public, media and worldwide medical attention (Whitehead 1981). The McGovern goals gave quantitative advice for change, advising Americans to increase their consumption of complex carbohydrates and naturally occuring sugars from about 28% to 48% of energy intake; reduce refined sugar to 10% of energy intake; reduce saturated fat to 10% of energy intake and reduce total fat to 30% of energy intake. Personalised versions from other western countries soon followed.

In 1978 the UK Department of Health and Social Security (DHSS) published 'Eating For Health' (Table 3). Though embracing the same doctrine as the USA dietary guidelines, it was very different in giving non-quantitative advice. Its qualitative advice gave direction for change without specifying the magnitude of change. Such an approach is arguably more scientific as it does not assume sufficient depth of knowledge of the dietary patterns of the target population with which to

TABLE 3

Eating For Health, DHSS 1978.

1. If babies can be breast-fed even for a few days or preferably, for a few weeks or months, it gives them the best possible start in life.

2. As soon as solid foods are started dietary trends towards foods other than milk are formed. In particular, sweet foods may help a child to develop a 'sweet tooth', and perhaps eventually to a loss of teeth due to dental caries; therefore sugar and confectionery should be limited.

3. During times of rapid growth - infancy and the pre-school years - sufficent vitamin D is important. Supplements may also be needed during puberty, pregnancy and when breast feeding. The house bound may also require them.

4. To make sure of a supplement of all the essential nutrients, the diet should comprise a mixture of foods from the five food groups: cereals, milk and dairy foods, fruit and vegetables, meat and fish etc., non-dairy fats and oils.

5. Obesity can mean ill-health or premature death. To avoid these, food intake should not be greater than necessary for energy expenditure. A practice of ensuring this is not to become overweight for one's height.

6. People need to watch the amount of fats and fatty foods they eat. Many people will need to cut down their intake of:

   VISIBLE FATS in the form of cream, butter, margarine, fat on meat, fried foods.

   INVISIBLE FATS in cakes, biscuits, puddings, pastry cream.

   SUGAR in sweets, chocolate, puddings, soft drinks, tea, coffee and other beverages.

7. The reduction in energy intake which results from eating less fat and less sugar can be made up by eating more bread and more fresh fruit and vegetables, including potato. All these foods are less fattening, weight for weight, than the fatty foods listed in 6.

8. It would do no harm to eat a little less protein.

9. To eat less salt might be beneficial.

10. Alcohol is not necessary.

(Source, Whitehead 1981)

advocate realistic proposals for change (Gibney 1990). The UK 1978 guidelines were progressive in making reference to the dietary needs of sub-groups of the population, such as babies and young children. Otherwise, dietary guidelines in general have been critised as being far too middle-age orientated (Whitehead 1981).

In 1979, shortly after the publication of 'Eating For Health', a National Advisory Committee on Nutrition Education (NACNE) was formed by the British Nutrition Foundation (BNF) and the Health Education Council (HEC) with representation from the DHSS, Ministry of Agriculture Fisheries and Food (MAFF) and from relevant health professions. The group was constituted in recognition of a growing emphasis on nutrition in preventative health measures. Its remit was to provide simple, accurate and unambiguous information on nutrition. In 1983 a 'discussion paper'was published. The recommendations are of a quantitative nature (Table 4) as, from previous experience, qualitative guidelines were deemed ineffectual. The suggested figures were based on 'the maximum agreement currently achieved by experts in nutritional science and epidemiology, from such experimental data as are available and from the massive other evidence that has accumulated in recent years'.

Table 4 Recommendations from the NACNE Report, 1983.

		SHORT-TERM	LONG-TERM
FAT (% of energy, incl. alcohol)			
Total	decrease to:	34	30
Saturated	decrease to:	15	10
Polyunsaturated	increase to:	5	
P/S ratio	increase to:	0.32	
SUCROSE			
(% of energy, incl. alcohol)		12	
Sucrose (g/d)	decrease to:	93	55
FIBRE (g/day)	increase to:	25	30
SALT (g/day)	reduce by :	1	3
ALCOHOL (%energy)	decrease to:	5	4

(Source, adapted from Nelson 1985).

The NACNE report was attempting to propose a modest programme of nutritional change for the 1980s. It was regarded as scientifically based, feasible, worthwhile, and realistic (NACNE 1983). The professed aim of the report was 'the maintenance of health and the primary prevention of disease, particularly those diseases of public health importance, such as heart disease'. The report stressed that the recommended values were not being targeted at individuals but at the mean intake of the whole population. The approach adopted by NACNE is to shift the distribution of nutrient intake in the desired direction, as many more susceptible individuals would then theoretically benefit.

This discussion paper was never adopted as government policy so has had minimal political impact on our agricultural and food production policies, unlike Norway's government sponsored Nutrition Food Policy. The Norwegian 'structuralist' approach takes into consideration links between nutrition and food, health, agricultural policy and socioeconomic development, so influencing the production, supply and pricing of food. This approach is unique in western industrialised countries, aimed at making it easier for individuals to make healthier food choices (Ziglio 1986).

The impact of the NACNE recommendations on nutritional research and nutrition education in the United Kingdom over the past eight years cannot be denied. The 'individual-oriented' approach adopted for the implementation of the dietary guidelines places emphasis on individual responsibility in reducing health problems and enhancing health status, through education-based programmes to change attitudes and behaviour (Ziglio 1986). In nutrition education emphasis is no longer placed on the properties of isolated nutrients, but on the role of foods themselves in a "healthy" diet (Church 1986). Concepts of nutrition are difficult to grasp irrespective of the academic level of teaching; much confusion persists in the knowledge of the general public (Bradley & Theobald 1988).

Though aimed at the whole population the NACNE report recognised the needs of special groups in the population. As regards young children it stated:

> "The diet recommended is likely to be bulkier and higher in fibre than usual, hence less energy dense. It may not satisfy all the nutritional requirements of a young child eating to appetite therefore should not be pushed to extreme limits."

Amidst the general approval of the NACNE recommendations by health professionals and its largely uncritical acceptance, a few voices were raised in objection to its 'draconian' measures (Clark et al. 1984). However, paediatricians and dietitians working with young children were concerned at the possibility of inappropriate application of the recommendations to young children, fearing a reduction in energy intake with deleterious effects on growth (Francis 1986).

In 1984 the DHSS Committee on Medical Aspects of Food Policy (COMA) published 'Diet and Cardiovascular Disease', based on an extensive review of the evidence linking diet with heart disease. This report gave quantitative recommendations for dietary changes to the fat component of the diet (Table 5). These recommendations were aimed at the average intakes of "individuals".

Qualitative guidance was given to 'increase fibre-rich carbohydrate'and 'decrease intake of salt'. Particularly controversial was the recommendation that 'intake of simple sugars (sucrose, glucose and fructose) should not be increased further'.

Table 5 Recommendations of the COMA Report, DHSS 1984.

FAT (% of energy, excl. alcohol)		
Total	decrease to:	35
Saturated	decrease to:	15
Polyunsaturated	increase to:	3.5 - 6.8
P/S ratio	increase to:	0.23 - 0.45
SUCROSE		No increase
FIBRE		Increase
SALT		Decrease
ALCOHOL (%energy)	decrease to:	8

(Source, adapted from Nelson 1985).

The COMA report was widely regarded as a 'softer' version of the NACNE report. Unlike the NACNE report, the COMA report specifically excludes children under the age of five from its recommendations. On this issue the opinion of dietitians and health professionals remains divided. Some argue that rapidly growing children are at risk of poor growth from a low fat/high fibre diet due to its low energy density, whilst others argue that such a diet should be introduced at an early age to encourage the development of healthy eating habits (BDA 1985).

As the weight of medical opinion is behind them, health professionals could be forgiven for appearing evangelical in their promotion of dietary guidelines. The latest USA guidelines, published by the National Academy of Sciences on March 1st 1989, are aimed at 'individuals' from early childhood to adulthood (Table 6). These USA dietary guidelines, from the report 'Diet and Health: Implications for Reducing Chronic Disease Risk', place a greater emphasis on reducing fat intake than previous UK guidelines, with less caution in relation to meeting the energy requirements of young children. There is no requirement for a reduction in sugar intake, which is barely differentiated from the starch component of carbohydrate, other than in an oblique expression of a preference for starch and other complex carbohydrates to effect an increase in total carbohydrate intake. Little credibility is allotted to any beneficial effects of dietary fibre. In relation to cancer the report states:

> "There is no conclusive evidence that the dietary fibre itself, rather than other nutritive and non-nutritive components of foods, exerts a protective effect against cancers."

TABLE 6

Recommendations of the National Academy of Science, USA 1989.

1. Reduce total fat intake to 30% or less of calories.

   Reduce saturated fatty acid intake to less than 10% of calories and intake of cholesterol to less than 300mg daily.

2. Eat 5 or more servings of a variety of fruit and vegetables daily.

   Increase intake of carbohydrate to more than 55% of total calories, primarily by increasing intake of starches and other complex carbohydrates, eating six or more daily servings of a combination of breads, cereals and legumes.

3. Maintain protein intake at moderate levels.

4. Balance food intake and physical activity to maintain appropriate body weight.

5. Alcohol consumption is not advised. Limit to equivalent of two glasses of wine daily.

6. Limit total intake of salt to 6g or less.

7. Maintain an adequate calcium intake.

8. Avoid dietary supplements in excess of the (USA) RDAs.

(Source, Nutrition Reviews, Vol 47 No 5, May 1989).

New dietary guidelines for the UK have very recently been published in a report of the Panel on Dietary Reference Values of the Committee on Medical Aspects of Food Policy, by the Department of Health (DOH 1991). The report stresses that the 'Dietary Reference Values' (DRV) for fat, sugar, starch and fibre are aimed at groups of people, not individuals (Table 7).

Table 7 Dietary Reference Values for UK adults.

	Pop^n mean intake as % energy	
	including alcohol	excluding alcohol
Saturated fatty acids	10	11
Cis-mufa	12	13
Cis-pufa	6	6.5
Trans-fatty acids	2	2
Total Fatty Acids	30	32.5
TOTAL FAT (equivalent)	33	35
Non-milk extrinsic sugar*	10	11
Starches, intrinsic sugars and lactose*	37	39
TOTAL CARBOHYDRATE	47	50
NON-STARCH POLYSACCHARIDE(g/day)	18	18

* assuming 15% of energy as protein.

The DRVs for fat, sugar and starch are similar to the short-term guidelines of NACNE (1983), though are actually slightly more severe in their promotion of a reduction in total fat, saturated fat and extrinsic sugar intake. In relation to dietary fibre, or non-starch polysaccharide (NSP) as it is frequently referred to, the suggested intake has been markedly reduced from 30g to 18g per day.

The DRVs of the Department of Health appear to relate to adults, as specified in the main summary table of the offical publication, with no reference to values for children of either pre-school or school age (DOH 1991). Further ambiguity is promoted by the text of the publication as values are often stated as relating to 'population average intakes', and in the abbreviated version of the guidelines are directed solely at the 'UK people' with no direct reference to either adults or children (DOS 1991, Salmon 1991). Only in the case of dietary fibre (NSP) are there specific recommendations for children. The panel states:

> '...children should have lower NSP intakes. Children of less than 2 years should not take such foods at the expense of more energy-rich foods which they require for adequate growth'.

For dietary guidelines to be effective they must be realistic expectations of the target populations ability to change dietary practice. The feasibility of the NACNE (1983) and COMA (1984) dietary guidelines were assessed, not by pilot studies, but on the observed dietary practices of non-western populations and on the more favourable dietary practices of earlier generations. Since 1984 several research papers have attempted to throw light on the ability of our present population to attain the dietary goals (Black et al. 1984, Nelson 1985, Cole-Hamilton et al. 1986, Bradley & Theobald 1988, Cade & Margetts 1989, Cade and Booth 1990).

Black et al. (1984), by means of a 7 day weighed record, compared the NACNE guidelines to the diet of a group of 42 dietitians previously studied in 1977 and also to the diet of 24 Cambridgeshire women.

The mean intake of sucrose for both groups was within the NACNE short-term goal 12% of energy (93g/day) and the dietitians actually achieved the long-term goal of less than 55g per day. However, both groups were taking more than 41% non-alcohol energy from dietary fat. The authors noted the difficulty in reducing both the % energy from fat and the % energy from sugar simultaneously and concluded that only the short-term NACNE goals were realistic without radical changes in eating habits. They should not be applied too literally to individuals.

Nelson (1985) re-examined the diet of a group of 217 adults studied from 1977 - 1979 by a 7 day semi-weighed diet record. Nutrient intakes were typical of the United

Kingdom adult population, with 33% of women and 50% of men obtaining more than 40% non-alcohol energy from fat. There was an inverse relationship between % energy from fat and % energy from sugar. Energy, vitamin and mineral intakes were generally higher in those people taking low fat/ high fibre diets. There was no major difference between consumption of total bread, butter and margarine or chips between high and low fat groups. On an individual basis, none of the subjects was achieving all of the NACNE short-term dietary goals, some achieved one or two of the goals though none for both sugar and fat. The main defect was observed to be an excess of sugar. It was concluded that the NACNE short-term guidelines would only be effective if suitable alternatives could be found for sugary foods, together with an increased intake of starch and other complex carbohydrates.

Three interventive studies of a similar design have assessed the effect of nutrition education on the dietary practice of adults.

Cole-Hamilton et al. (1986) carried out a study among dietitians and adult members of their households to determine whether a group of motivated people could actually achieve a modified version of the long-term NACNE goals. 472 adults participated, initially weighing their normal diet over a 7 day period. Except for fat, mean group nutrient intakes were within the short-term NACNE goals.

During a second 7 day phase subjects were asked to make an effort to achieve the dietary guidelines, whilst maintaining energy intake, the target for fat being set at the long-term NACNE level of 30% of energy intake. 43% of subjects achieved the dietary goals during this week, though for both men and women there was a significant drop in energy intake. The reduced energy intake, a result of a lowering of both fat and sugar intake, was not compensated for by an increased intake of starch and complex carbohydrates. This was related to the increased bulk of the diet and lack of suitable foods to eat. It is interesting to note that whilst the NACNE goal of reducing "added sucrose" was achieved, intake of "total sugars" in the diet actually increased during the second week, presumably as a result of an increase in natural sugars from fruit and fruit juices.

Two similar studies based on the methodology of Cole-Hamilton et al. (1986) examined the effects of dietary modification as defined by the NACNE short-term goals.

Warwick & Williams (1987), were particularly interested in examining changes in fat and fibre intakes in 37 Australian adults after a period of nutrition education. The volunteers did reduce their fat intake but failed to increase their intake of complex carbohydrates to maintain energy intake. Such a diet could therefore not be maintained indefinitely. A one year follow-up study, however, did suggest that favourable adaptation had occurred with an increased intake of complex carbohydrate and fibre, whilst maintaining a reduced fat intake.

Bradley & Theobald (1988) in a study of 28 UK adults, found that fat and energy intakes also fell during the second study week. Subjects with a low calorie intake had greatest difficulty in increasing their fibre intakes. As a group, all the short-term NACNE goals were met, except for fibre. The authors concluded that it is difficult to change eating habits and a wider range of alternative healthy foods are required.

Using a single 24 hour self-completed dietary record, Cade & Margetts (1989), studied the diet of 2340 middle-aged men and women in three English towns in an attempt to describe the food intake of people meeting all, or a combination of, the short-term NACNE and COMA guidelines. Less than 2% of the subjects were meeting all of the goals. 7% achieved the COMA goals for total fat and saturated fat though they had a lower energy intake than those not meeting the fat goals. Only 10 subjects met the carbohydrate, fibre and sugar goals. The conclusion from this study is that few people were meeting any single dietary goal and even fewer were meeting a combination of goals (Cade & Booth 1990).

The feasibility of dietary guidelines, eight years after the publication of the NACNE report, is a topical subject. Gibney (1990a), in a critical appraisal of dietary guidelines, draws attention to the apparent incompatibilty of recommending a reduction in intake of both fat and sugar in the diet. In recent years, he argues, such recommendations have led to a counterproductive reduction in total energy intake, resulting in similar values for % energy from fat and sugar as in the pre-NACNE era.

Undoubtedly we shall see a plethora of dietary surveys over the next decade aimed at assessing the ability of our population to adhere to the new Dietary Reference Values for fat, sugar, starch and fibre. With government support, the possibility of introducing food policies to influence food production and pricing may perhaps result in a more favourable outcome than was achieved in the post-NACNE years.

No studies are available for schoolchildren or adolescents that seek to determine the effect of nutritional guidance on nutrient intake. Hackett et al. (1990) used a self-completed questionnaire with 700 11 - 12 year old schoolchildren to evaluate a "healthy eating" campaign. Though the campaign was deemed "successful" as it altered the choice of foods eaten, no information is available about the effect of nutrition education on the children's actual nutrient intake.

Despite a dire lack of scientific information with which to substantiate the feasibility of dietary guidelines for schoolchildren and adults, at least within the context of the current UK diet, a large proportion of health education resources are currently directed at the promotion of dietary recommendations. In light of the results of recent studies in adults it is imperative that target populations are nutritionally assessed prior to and following the issue of dietary guidelines. Pilot studies to assess feasibility would improve the scientific credibility of nutritional goals. Gibney (1990) concludes:

> "The credibility of nutritionists and dietitians will diminish if the advice offered is not effective, not feasible, not practicable. In other words, poorly thought out".

The credibility, feasibility and practicability of the DOH (1991) Dietary Reference Values for fat, sugar, and starch remain to be proven. In the interpretation of studies it is important to bear in mind that DRVs relate to groups, not individuals, as it is clearly difficult for any individual to achieve the values for both fat and extrinsic sugar simultaneously, without adaptation to higher starch intakes.

NUTRITIONAL ASPECTS OF THE DIET OF PRE-SCHOOL CHILDREN.

Children's diet and change.

After publication of the NACNE report (1983) and the COMA report (DHSS 1984) the British Dietetic Association (BDA) responded to expressions of anxiety from its membership by forming a working party to review world literature, aimed at clarifying the effect of changing the diet of children under five along the lines suggested for adults. The BDA report 'Children's Diet and Change' was published in April 1987.

The BDA working party approached its task by dividing the diet into components, thus the topics of energy, fat, sugar, fibre, salt, vitamins and minerals were researched and reported independently. The overwhelming finding of each topical area was that little scientific evidence is available, particularly in relation to British children, from which to draw conclusions. No studies were found investigating the effect of NACNE/COMA type recommendations on the diet, nutritional intake or growth of the 0 - 5 year age group.

In relation to energy density the BDA report stressed that low energy dense diets of 1 kcal/g have been found to cause undernutrition and impaired growth in children in third world countries. The typical UK diet of young children is said to provide 2-3 Kcal/g.

The report had little to offer towards elucidating the role of dietary fat in infancy as a risk factor for CHD. On reviewing the evidence linking diet to serum lipid levels in pre-school children, it concluded that genetic endowment is the single most important factor influencing serum lipid levels in early life. A conclusion that is itself controversial.

A Canadian study by Yeung et al. (1982) reported the finding that a high proportion (50%) of six month old infants were being fed low fat/low calorie semi-skimmed milk. They were growing normally and appeared to compensate for a low fat intake by increasing their intake of calories from other sources. The use of skimmed or semi-skimmed milk in infancy, rather than full fat milk may, however, be contraindicated as it could result in a diet that presents a higher solute load to the kidney, due to infants compensating by drinking larger volumes of milk (Fomon et al. 1979). Recommendations from the USA, Canada and New Zealand suggest that skimmed or semi-skimmed milk can be given after one year of age (BDA 1987).

The BDA report placed emphasis on a study by Cohen et al. (1979) that reported a higher incidence of diarrhoea in 44 infants aged 6 - 36 months taking a diet that provided less than 27% of calories from fat. Growth was not affected. Supplementing the diet with fat reduced the incidence of diarrhoea. It is postulated that fat acts by stimulating hormones that inhibit gastric emptying.

In relation to sugars the BDA report said that relatively little information is available on the effects of sugars on healthy children. Not surprisingly, the role of sugar in dental caries was highlighted. No evidence was found that overweight children eat more sugar, nor or of a link between hyperactivity and sugar. The report stressed that little information is available on the normal sugar intake of children aged 0 - 5 years, nor on sources of sugar in the diet.

The BDA discussion in relation to desirable fibre intakes was largely of a theoretical nature. It stated that 'the majority of evidence for the beneficial effects of fibre is epidemiological and refers almost entirely to adults'. No studies were found with which to determine the effect of fibre intake on colonic function in paediatrics and there were no recorded desirable fibre intakes. Two theoretical objections to a high fibre intake were given:

1. High bulk may restrict energy intake.
2. High fibre diets may reduce mineral absorption.

Despite a paucity of scientific evidence with which to support the need or practicality of dietary guidelines for young children, and a self-professed need for caution, the final recommendations of the BDA working party (Table 8), are not far removed from the NACNE ethos, though admittedly non-quantitative.

The BDA recommendations are directed primarily at reducing sugar intake in children to reduce the incidence

TABLE 8

Children's Diet and Change, BDA 1987.

1. Energy requirements which depend on age, sex and physical activity, must be met for each iindividual child in order to obtain optimal growth.

   On milk intake, a COMA statement from the Panel on Child Nutrition, February 1987, is quoted:

   "Where semi-skimmed milk is in general use in a home there are no strong objections to its progressive introduction from the age of 2 years provided the child's overall dietary intake is adequate".

2. After weaning, lean meat, fish, poultry, egg, cheese, fruit, vegetables, bread and wholegrain cereals should form the major part of a child's diet. Sugary foods and drinks are not recommended due to their role in the development of dental caries and because they provide only energy, thus their intake should be limited. Fried foods adn high fat foods, including chips, should be limited or reserved for special occasions.

3. Changes should not be made in a young child's diet that might compromise energy intake and optimal growth.

4. As whole foods are bulkier, frequent 'sensible' between meal snacks are recommended.

of dental caries, as the scientific evidence linking diet with this disease was deemed strongest. A moderate reduction in fat intake and an increased intake of complex carbohydrate was advised. This report, written jointly by community and paediatric dietitians, now forms the basis of BDA healthy eating policies for pre-school children.

In 1988 the COMA Panel on Child Nutrition published 'Present day practice in infant feeding: Third report', its latest statement on nutrition for 0 - 5 year olds (DHSS 1988). In relation to current adult dietary guidelines, caution is advised against the deliberate restriction of fat intake without compensating for energy intake. The need for updated nutritional information on pre-school children is recognised.

In 1988 the UK Coronary Prevention Group also published dietary recommendations for the prevention of heart disease. They had few qualms in advising children over 2 years to follow a low fat diet.

Coronary Heart Disease and the pre-school child.

For older children and adults there is a recognised link between a high fat diet, raised serum LDL cholesterol levels and coronary heart disease (CHD). Dietary guidelines aimed at reducing the risk of heart disease advise a reduced fat diet providing 30% - 35% energy from fat (NACNE 1983, DHSS (COMA) 1984). In the United Kingdom caution is advised in the application of this advice to pre-school children as there is uncertainty of the suitability of a low fat diet for young children and of its effectiveness in diminishing the future risk of CHD. Diet is just one of the many "risk factors" for CHD that includes raised blood pressure, familial tendency, smoking, stress, obesity, and lack of exercise (Taitz 1987).

The cautious approach of British practitioners undoubtedly arises from a paucity of UK research to examine the importance of risk factors for CHD in childhood, or the effect of a low fat diet on growth and development in childhood (BDA 1987, Coronary Prevention Group 1988). The influence of diet in the early years in shaping lifelong eating habits is now well recognised.

A strong body of non-UK research evidence, particularly from the United States, implies that atherosclerosis begins to develop in early childhood. It has been known for over thirty years that fatty streaks can be found in the aortas of 3 year old children, and in coronary arteries during the teenage years (Newman et al. 1986). Evidence of coronary atherosclerosis in young adults was found in pathological studies of the coronary arteries of young men in World War II, and in the Korean and Vietnam conflicts, with up to 77% of coronary vessels affected (Kwiterovich 1986, McNamara et al 1974, Enos et al 1953).

Since the early 1970s the Bogalusa Heart Study has investigated risk factors of CHD in a large cohort of

American children from birth. It has confirmed that risk factors for cardiovascular disease are related to even the earliest stages of grossly visible atherosclerotic lesions in the young (Newman et al. 1986). The extent of aortic fatty streaks was strongly related to concentrations of both total and LDL cholesterol. Fatty streaks in the coronary arteries were correlated with VLDL cholesterol, raised serum lipid concentrations and high blood pressure (Newman et al. 1986). American studies have also found evidence of a gradual transition from fatty streaks to more advanced fibrous plaque in the coronary arteries, beginning in some cases before 20 years of age (Kwiterovich 1986). Fibrous plaques are the precursors of symptomatic heart disease such as myocardial infarction or angina pectoris.

Evidence from the Bogalusa Heart Study and other major USA studies of risk factors for CHD in childhood, show that serum cholesterol levels "track" significantly during childhood. It is predicted that about 25% of American children will develop cholesterol levels of 240 mg/dL or higher by 40 year of age, and will be at moderate risk of CHD as adults (Kwiterovich 1986).

Children of families who have adult members with hyperlipidaemia and/or early heart disease are at greater risk of high blood cholesterol levels (Deckelbaum 1990). However, while genetic influences are of significance in determining serum cholesterol levels in childhood, there is clear evidence of a relationship with saturated fat consumption, and also with body weight (Coronary Prevention Group 1988).

Studies of very young infants receiving commercial milk formulas of varying fatty acid compositions have shown pronounced effects on plasma cholesterol levels (Kwiterovich 1986). The cholesterol content of the formula was less important in determining plasma blood cholesterol concentrations than the intake of saturated fat (Deckelbaum 1990). Similar effects have been found on varying the total fat and cholesterol intake, and ratio of saturated fat:polyunsaturated fat, in the diets of American pre-school children and adolescents (Kwiterovich 1986). In contrast to American studies, Andersen et al. (1979) in a study of 64 Danish pre-school children age 3 - 4 years, and Parizkova et al. (1986) in a study of 22 Czechoslovakian children aged 3 - 5 found no significant relationships between energy or fat intake and blood lipid levels.

In American children, as in adults, reducing total fat intake to 30% of total calories and saturated fat intake to 10-15% of total calories has been shown to reduce total plasma cholesterol levels by up to 15% (Deckelbaum 1990). In general, children with a higher initial plasma cholesterol level show a greater response than those with a lower initial cholesterol level. Thus diets restricting total cholesterol and saturated fat will lower the plasma total cholesterol level in most children, but the response is variable (Kwiterovich 1986).

Ideally, the effect of dietary modification in childhood on plasma cholesterol metabolism, plasma cholesterol levels and on the incidence of coronary heart disease in adulthood, should be monitored in a prospective study. Such information is not yet available (Lauer et al. 1988).

Results of clinical trials of adults on either diet alone, or lipid lowering drugs, suggest that for each 1% lowering of plasma cholesterol, there is a 2% reduction in the incidence of CHD (Kwiterovich 1986).

The relationship of blood pressure in childhood to adult risk of CHD is unclear, though there is some tendency for children with raised blood pressure to become hypertensive adults. It is also unclear whether a reduction of salt intake in childhood can reduce blood pressure (Coronary Prevention Group 1988).

In view of the above evidence linking diet with atherosclerosis, dietary guidelines for children over 2 years were released by Weidman et al. on behalf of the American Heart Association (AHA) in 1983 and by the USA National Institutes of Health Consensus Development Panel in 1985, advising childhood diets of a similar nature to those currently recommended for adults. The AHA recommended that all children over 2 years of age should reduce total fat intake to about 30% of total calories with 10% or less being provided by saturated fat and no more than 10% by polyunsaturated fat. Children should also reduce cholesterol intake to 100mg/1000 Kcal. This would require a 16-18% decrease of fat intake for American children aged 2 - 18 years who normally have an average fat intake of 36 - 38% of total energy (Deckelbaum 1990). The views of the Committee on Nutrition of the American Academy of Paediatrics (1986) are a little more cautious, recommending an unspecified "decrease" in cholesterol intake for children over 2 years and a fat intake of 30 - 40% of energy intake.

In 1988 a policy statement from the Coronary Prevention Group of the UK recommended a "progressive reduction of fat in childrens diets, beginning from the age of 2 years and reaching the levels recommended for adults by 5 years. This will involve the introduction of low-fat milk, but with proper attention to calorie and vitamin intake." This cautious approach still elicited the wrath of health professionals averse to any modification of the diet of pre-school children, until it can be adequately demonstrated that dietary restrictions are needed and will support growth and development (Durnin 1988).

Kwiterovich (1986) reviewed the safety of modified diets on growth and development. He emphasised that there is no theoretical reason why a decrease in cholesterol and saturated fat in the diet per se may be deleterious to growth and development, provided there is an adequate supply of energy, protein, vitamins, minerals and other nutrients. An American study is cited in which no significant differences were found in height and weight percentiles at 3 years, in children following a low fat/low cholesterol diet from birth. The diet recommended by the AHA is in fact very similar to the normal diet of Italian, Greek and Israeli children (Deckelbaum 1990).

Some caution has been voiced with experience in regard to growth failure following treatment of hyper-cholesterolaemia in childhood. Lifshitz and Moses (1989) described nutritional dwarfing in 3 out of a group of 40 children, due to unsupervised dietary modification. The growth in height and weight of 32 children was normal, progressing along the same percentile lines after diagnosis. These normally growing children were taking an average of 30% energy from fat. In 5 patients weight fell following unsupervised dietary treatment of hypercholesterolaemia, on a diet providing 25% of energy from fat and a lower total energy intake than that of children of normal weight. Their height velocity was not affected. However, the diet of the 3 children with linear growth failure had only 20% (s.d. 2%) energy from fat, and less than 60% of the recommended energy intake. Their diets were also generally inadequate in vitamins and minerals. In view of these results Lifshitz and Moses advise caution in recommending a low fat/low cholesterol diet during the first two decades of life.

Vegetarian diets in childhood.

Over the past twenty years the popularity of vegetarian diets has increased in Britain, partly in relation to the expansion of ethnic minority groups and partly due to a trend towards seeking a more natural, healthier life-style.

Children born into vegetarian families are generally weaned and reared on a vegetarian diet. An interest in the growth and development of such children, with concern for their welfare, has led to many nutritional studies of vegetarian children. These studies provide us with the opportunity to assess the effect of a high fibre/low fat diet on growth in childhood.

Sanders and Purves (1981) reported on the growth and dietary intakes of 23 British vegan children age 1 - 5 years (mean age 31 months). Most children had been breast-fed into the second year of life, a pattern atypical of the general population. Longitudinal growth data was not presented, thus growth velocity was not assessed. However, the heights and weights of all chidren (except one with diagnosed allergy) were within the normal range and so as a group were regarded as growing normally. The mean heights and weights were slightly below the 50th centile for boys and girls. The diet of these vegan children was generally adequate. Energy intake was deemed low at a mean of 85% (s.d. 3) of the 1979 DHSS recommended amount. Fibre intakes were extremely high (mean 18 g/day, s.d. 2, range 4 - 37g/d). Fat provided approximately 30% of calories. Sanders and Purves concluded that with sufficient care a vegan diet can meet the nutritional requirements of the pre-school child.

Sanders (1988), in a follow-up study of the above children, found growth velocity and intellectual development to be normal, though the mean height of boys and mean weights for both sexes were still below the 50th centile. Their diet was very similar to that taken in the pre-school years, with low energy intakes and a mean fat intake of 30% (range 16 - 39%) of total calories. Sanders stresses that there are adequate and inadequate vegan diets and warns against the effect of severe fat restriction on the energy density of the diet. Energy dense foods, such as cereals, pulses and nuts should take precedent over fruit and vegetables. Interestingly, the average micronutrient density, including iron and vitamin B_{12}, expressed as nutrient/1000 kcal, of vegan diets was found to be higher (except for calcium) than the average UK diet (Sanders 1988).

In America, The Farm Study has examined the growth of 404 vegan children aged 4 months to 10 years who lived in a collective community in Tennessee. Dietary information is very limited. Most children were known to take dietary supplements. The results suggest that growth of the children was normal, thought the mean height for age and weight for age were slightly lower than that of the reference population (O'Connell et al. 1989).

Sabate et al. (1990) in another American study, compared the height and weight of over 1000 Seven Day Adventist (SDA) schoolchildren age 6 - 18 years, who were predominantly lacto-ovovegetarian, to over 1000 public schoolchildren. For both sexes in each group the mean height and weight were at or above the standard reference values. The SDA boys were significantly taller and leaner than the public school boys. The SDA girls were significantly leaner. The authors conclude that a health-oriented lifestyle in childhood and adolescence, such as the one followed by Seven Day Adventists, is compatible with adequate growth and associated with a lower weight for height.

Van Staveren and Dagnelie (1988) reviewed four studies examining food consumption, growth and development of Dutch chidren fed on alternative diets. A cross-sectional study of 300 macrobiotic children aged 0 - 8 years showed significantly impaired growth after 5 months of age, with no catch-up growth, mental development did not appear to be affected.

In 1988 Jacobs and Dwyer published a comprehensive review of research examining appropriate and inappropriate vegetarian diets for children. Inappropriate vegetarian diets include very restrictive, unplanned patterns, such as those consumed by some Macrobiotics, Black Hebrews and Rastafarians. Severe malnutrition has been reported in infants of such regimes, with cases of rickets and other mineral and vitamin deficiencies. The weight, and in particular length, of macrobiotic children tends to deviate from the reference population at about one year of age, probably due to a low energy intake (Jacobs and Dwyer 1988). The diet of less restricted vegetarians, who include milk products, usually obtain their nutritional needs. Lacto-ovo-vegetarian diets pose fewer problems at weaning and tend to be lower in bulk.

Jacob and Dwyer (1988) also reviewed the possible benefits of vegetarian diets in childhood, reporting a decreased incidence and prevalence of some chronic degenerative diseases among vegetarians, including high blood pressure and cardiovascular disease, due perhaps, to an apparently lower level of serum lipids. They suggest that appropriate vegetarian and non-vegetarian diets, low in total fat, saturated fat and cholesterol and high in complex carbohydrate and fibre, may be closer to recent dietary recommendations for children than is the usual American diet.

In conclusion, it would appear that children on extreme vegan-like diets are at high risk of nutritional deficiency and growth retardation. More liberal vegetarian diets, including milk and/or egg, though low in fat and high in fibre, can provide adequate nutrition and may help establish lifelong healthy eating patterns.

The family environment and nutrition of the pre-school child.

The experiences of early childhood shape our eating habits, lifestyle, social capabilities and intellectual performance throughout life. It is extremely difficult to change established habits.

As young children are highly dependent on their parents for food, parents are therefore very influential in shaping their children's likes, dislikes and future eating habits. The mother is usually the strongest influence as she is most closely involved with food preparation and presentation. A mother who is herself a fussy eater may unnecessarily restrict her child's diet by not offering foods she herself wouldn't eat, the child thereby inheriting the mothers fussy eating habits. However, as the father's preferences often dictate the family diet he is also a powerful influence on the child's eating habits. Young children who are offered a wide variety of foods are less likely to be fussy and are more willing to try new tastes and dishes (Lennon and Fieldhouse 1982). Newson and Newson (1968) found about 30% of 4 year old children to be variable and finicky eaters.

Unwittingly, many parents use food as a system of reward and punishment. In our British culture sweet foods are often used as gifts, treats and tokens of affection as well as rewards and bribes. Sweet foods are associated with goodness, the word "sweet" itself used as a substitute for 'nice'. Unfortunately, a sweet tooth acquired in childhood tends to persist into adulthood. As adults many of us crave sweet foods when tired, upset or anxious. Foods thus take on an emotional significance for the child. Eating can be used as a substitute for love, deprived children or adults using food as a comfort (Fieldhouse 1986).

The reasons why people eat 'what', 'when' and 'where' are very complex. Believing that a food is bad for health does not necessarily stop it from being eaten, nor do people necessarily choose to eat foods that are thought to be good for them. Social, cultural and economic influences combine with individual beliefs and preferences to determine a person's diet. Attempts to change people's eating habits thus often meet with failure.

It is essential that nutritionists are aware of the social aspects of eating behaviour when formulating dietary guidelines or evaluating nutrition education programmes.

Mealtime behaviour between families is also extremely variable. Heptinstall et al (1987), in a study comparing growth retarded pre-school children with normal children, found considerably more disorganisation and negative attitudes in case group families. Anxiety, tension or complete indifference were more common, as also were chaotic meals of a 'grab what you can' nature with poor or no table seating facilities. However, significantly more mothers of growth retarded children regarded 'helping themselves' as stealing, though there was apparently no difference in total food intake between growth retarded children and children of a normal height. The effects of eating behaviour and parental attitudes on nutrient intake in young children is a poorly researched area, the authors conclude that future surveys of child nutrition should include observations of mealtime behaviour.

Diet and Hyperactivity.

Whilst our social behaviour and eating habits undoubtedly influence food intake, the direct effect of food itself on behaviour is a more controversial subject. A link between diet and hyperactivity, or hyperkinesis, was proposed by Feingold (1975). He suggested that some children, especially boys, are sensitive to naturally occuring salicylates, various additives and artificial colourants, causing adverse behavioural symptoms. The diagnostic criteria of hyperactivity varies but generally includes a poor attention span, impulsive behaviour with excess motor activity, aggression, eating and sleeping problems, social difficulties and learning disorders (Thomas 1988). There is little scientific evidence to support Feingold's theory. Egger et al. (1985), in a carefully controlled double-blind cross-over trial of 76 hyperactive children, found significant improvements on an oligoantigenic diet, thus some children may indeed respond to dietary manipulation. The incidence of hyperactivity in the UK is thought to be low, in the region of 1/1000 (Dickerson and Pepler 1980). The causes of hyperactivity are obscure. It may relate to a food allergy in some children, a genetic tendency, smoking in pregnancy, parental attitudes or family stress in others. Many parents unfortunately attempt to manipulate their child's diet without medical supervision, a potentially dangerous practice (Thomas 1988).

Diet and food allergy.

Many childhood disorders are now believed to be associated with food allergy or food intolerance. A true allergy incites a detectable immune reaction with raised blood levels of IgE, food intolerance does not. However, the distinction has become obscured in both the medical and lay press (Cant 1985).

Food allergy has been implicated as a causative factor in urticaria, eczema, rhinitis, asthma, colic, infantile colitis, cows milk protein enteropathy, migraine and hyperactivity (Cant 1985).

Diagnosis of food allergy is extremely difficult as present tests are inadequate and almost any food item could be the offending allergen. Whilst one child may respond to elimination of a particular food another child with identical symptoms may not. Food most commonly causing allergy symptoms are cows milk, egg, fish, nuts, chocolate and artificial colours.

The incidence of food allergy in young children is not known but believed to be low, though rising. In preschool children the incidence of eczema is thought to be as high as 12% (Cant 1985). The most common causes of food related eczema are cows milk and eggs. Asthma is the commonest cause for admission to a children's ward in this country. Much research into the association of asthma with food allergy remains to be undertaken.

Self diagnosis of food allergy by parents is common. Self-treatment of a child by dietary manipulation without dietetic advice and medical supervision could have deleterious consequences.

THE ASSESSMENT OF GROWTH.

From conception to maturity the growth of a child normally proceeds along a closely regulated pathway, altering body composition and the relative proportions of organs, tissues and shape as the child matures.

Growth of an individual is a highly complex process, of which very little is as yet understood. Regulation of growth is genetically predetermined, influenced by race, sex and parental height and controlled by the endocrine system. However, there are many environmental influences on the rate of growth of a child such as socioeconomic conditions, disease and infection, psychological stress, climate and nutrition.

The study of growth is a powerful tool for monitoring the health and nutrition of populations, especially in sub-optimal conditions, and providing parental size is known, is also a prime measure of an individual child's physical and mental health (Tanner 1989).

In a comprehensive review of growth, "Foetus into Man; Physical Growth from Birth to Maturity", Tanner (1989) emphatically reminds us that 'bigger is not better'. Whilst wealthy people in developed countries are taller the same does not necessarily hold true in other ecological conditions where the small body size may be more adaptive and more economically efficient.

Growth of a child is monitored by plotting anthropometric measurements on standard growth charts at regular intervals of 3 - 12 months. Several measurements may be taken, such as height, weight, skinfold thicknesses, mid-arm and mid-calf circumferences. From these measurements the size of a child at a given age can be assessed, and also the rate (velocity) of growth. Velocity of growth actually gives a better reflection of the child's state at any particular time than does size achieved, as the latter depends largely on how much the child has grown in the preceding years (Tanner 1989). Traditionally both height and weight have been taken as the most represenative indicators of growth in childhood. Much emphasis has been placed on the weight of a child, particularly weight for height, assessment often being based on measurements taken on a single occasion. This is of questionable value as, for instance, a child who has an endocrine disorder can be fat and small for age. In small children normal fluctuations in fluid balance can mask underlying changes in body weight. However, in countries where malnutrition is endemic, children are assessed infrequently and actual age is often unknown, weight for height is a very practical means of assessment (WHO 1979). To aid this process of assessment WHO in 1979 published 'Measurement of Nutritional Impact' - A guideline for the measurement of nutritional impact of supplementary feeding programmes aimed at vunerable groups. This gives standard tables of weight for height based on a well-nourished population of American children, prepared by the National Centre for Health Statistics (NCHS) in the USA.

In industrialised countries height is regarded as the most revealing parameter of growth. A healthy, well-nourished and emotionally stable child will have a normal velocity of growth in height whatever the actual height. Temporary falterings due to episodes of mild illness are usually compensated for by a brief period of catch-up growth, and growth velocity over a period of a year, and adult height, are normal (Tanner 1989, Kelnar 1989).

Amongst individual children there is a wide variation in both height at any age and velocity of growth, the dominant factor affecting this normal variation being parental size. Basic standards of growth for British children give the normal range as percentiles of height, weight, height velocity and weight velocity. They were prepared by J.M. Tanner and R.H. Whitehouse from children measured during the 1950's, largely from the London area and Oxford, and are still used to reflect growth in our current population of children (Tanner, Whitehouse & Takaishi 1966; Tanner 1989). Similar standards are available for North American children (Tanner & Davies 1985). By comparison, British children tend to be slightly smaller and lighter than American children.

Growth curves are also available for the subcutaneous fat layer, measured by readings of skinfold thickness using skinfold calipers (Tanner and Whitehouse 1975). This is regarded as giving a better measure of adiposity than weight (Kelnar 1989). The data used to construct the Tanner and Whitehouse charts was collected during the 1950's and 1960's. The values from more recent studies have tended to cluster around the 10th centile of these charts, suggesting that they are no longer appropriate standards (Thomas 1988).

Waterlow and Payne (1975) estimated the average energy requirements of growth for a one year old child as:

Maintenance	79 Kcal (330 kJ)/kg/day
Normal growth	5 Kcal (20 kJ)/kg/day
Physical activity	19 Kcal (80 kJ)/kg/day
TOTAL	103 Kcal (430 kJ)/kg/day.

Growth will cease if calorie intake falls below the maintenance requirement. Before this time however, physical activity is reduced which affects play behaviour and social interactions. This effect may be more responsible for the delay in intellectual and emotional development that tends to accompany delayed growth, than a direct nutritional effect on the nervous system (Tanner 1989).

The minimum protein requirement for growth in infancy is a protein:energy ratio of 1:20 (5% of energy intake). A diet adequate in energy will almost certainly supply adequate protein.

In underprivileged societies malnutrition is a major cause of delayed growth, the principal deficit being energy intake. The next major growth antagonist is infection, especially diarrhoeal disease. A reduced food intake, rapid fluid losses and malabsorption cause a negative nitrogen balance. If this is not followed by adequate food for catch-up growth, growth velocity declines. Children with severe malnutrition in early infancy can make a complete physical and intellectual recovery, providing they receive adequate nutrition and social stimulation (Tanner 1989).

Social stimulation and the emotional well-being of a child are essential growth promotors. Psychosocial stress can cause failure to thrive due to an altered appetite and inhibition of the secretion of growth hormone. Skuse (1989) describes delay in growth due to emotional abuse, where there is usually no detectable organic disorder, but a dysfunctional secretion of growth hormone and exceptionally short stature. This condition is found in all socioeconomic groups of society and is often very difficult to diagnose.

The socioeconomic status of a child is usually defined by the Registrar-General's classification of the father's occupation. British children from different socioeconomic groups tend to differ in size and rate of growth, with those of "manual" fathers tending to be smaller than children of fathers in "non-manual" occupations. Socioeconomic status is today however, a very poor indicator of standard of living, or child care, in the home. Partly for this reason, perhaps, socioeconomic differences are no longer apparent in some countries, such as Norway and Sweden (Tanner 1989).

Other influences on the velocity of growth include season and climate. Seasonal variations are particularly relevant in western European countries, such as Britain, where children may grow up to three times faster in spring and summer than during winter. It is therefore important to study growth velocity over a 12 month span.

In conclusion, when studying growth in relation to diet and health many factors must be taken into consideration. For groups, but not individuals, height can be taken as a proxy for health. Tanner (1989) states: 'In all societies, classes, and at all educational levels, height is perhaps the most useful measure of healthiness'. However, to examine influences on the growth process itself height velocity is better, for the study both of groups and individuals.

DIET SURVEY METHODOLOGY.

The pursuit of methodology to accurately assess the nutritional intake of individuals and groups of people has preoccupied nutritionists for the past 60 years. Many methods have been described and their validity statistically defined. The most accurate means of determining an individual's usual food and nutrient intake remains the weighed inventory method, originally developed by McCance and Widdowson during the 1930's (Marr 1971, Bingham 1987, Bingham 1988, Borrelli 1990).

There are two distinct categories of diet survey methodology:

1. Direct recording - weighed record
   estimated record
2. By interview - 24 hour recall
   diet history
   food frequency questionnaire.

Each method has favourable aspects and drawbacks. The method of choice for a dietary survey will depend upon balancing these aspects, as described below, with the particular circumstances of the survey, such as whether or not clinical parameters are being measured and characteristics of the sample, such as sample size, age, intelligence.

Weighed methods.

Two types of weighed methods are documented in the literature, the precise weighing method and the weighed inventory method.

The precise weighing method requires all raw ingredients used in the preparation of dishes to be weighed, as well as the inedible waste. The cooked portion weight and leftovers are also recorded. Nutrient intake is either analysed from the raw weights of food using food composition tables or duplicate portions of food are collected and chemically analysed. This method is time consuming, costly and requires a high degree of co-operation from the individual, thus it is not believed to give a true representation of an individual's normal food intake (Marr 1971). It is most commonly used in clinical metabolic balance studies and in laboratory based energy balance studies.

The weighed inventory method (normally referred to as 'the weighed record') requires the subject, or carer, to weigh and record all food and drink immediately before eating and to weigh any leftovers. Details of recipes are required. The subject is given a set of equipment, including accurate scales, instructions and a recording book. The researcher usually explains the methodology to the subject either in the home or in a clinical setting. This is followed by a degree of supervision, balance being sought between an excessive amount that may interfere with the normal home routine and an inadequate amount in an attempt to avoid upsetting the normal eating patterns (Marr 1971, Bingham 1988). Nutrient intake is calculated from appropriate food tables.

As weighing food at every meal requires a high degree of commitment and subjects are usually volunteers, it can be difficult to obtain a representative sample of the study population (Marr 1971), though this is not perhaps as great a source of bias as is sometimes suggested (Bingham 1987, Bingham 1988). A minimal cooperation rate of 80% of a randomly selected sample is often quoted as essential to avoid selection bias (Bingham 1987, Bingham 1988), though rarely attained for weighed surveys (Bingham 1987).

To improve subject compliance with the weighed record, automatic electronic weighing and recording instruments have been developed. A Portable Electronic Tape Recording Automated scale (PETRA) was developed by Bingham et al. (1985); this simultaneously weighs food and records a verbal description of the food portions. Barker et al. (1988) compared use of the PETRA to electronic digital scales in the conventional weighed technique and found no significant difference in compliance. The PETRA was more popular with subjects than normal electronic scales but was considerably more time consuming on the part of the field worker in the transcription and coding of dietary data. It is also much more expensive. An alternative automated instrument, a Food Recording Electronic Device (FRED) was described by Stockley et al. (1986a). This is essentially an electronic digital scale interfaced to a computerised coding device. Foods are automatically coded by the subject from approximately 50 food groups on the computer keyboard, considerably reducing fieldwork time. Values obtained using food groups were not found to be a source of error compared to the use of detailed food tables (Stockley et al. 1986). The FRED has two fundamental drawbacks, the subject must be intelligent with a knowledge of foods and it is extremely expensive. Therefore the FRED is not suitable for use in studies of randomly selected free-living individuals.

Accuracy of the weighed inventory record can be improved by randomising the study days, whilst including a mix of week and weekend days, as opposed to a single block of consecutive days. This also helps to reduce inaccuracy due to fatigue (Bingham 1987, Bingham 1988).

The number of days of recording necessary depends upon the nutrients to be studied and the degree of precision required. This can be determined from the average within-person variation in daily nutrient intake (Marr and Heady 1986, Bingham 1987, Bingham 1988). For clinical or research purposes, where the nutrient intake of individuals is to be correlated with biochemical or physiological parameters, a precision of +/- 10% standard error of the mean nutrient intake is necessary (Bingham 1987, Bingham 1988). In adults this can be obtained for energy, carbohydrate and protein from a 7 day weighed record, though 10 or more days are required for fat, fibre, minerals and vitamins (Marr and Heady 1986, Bingham 1987, Bingham 1988). However, Bingham (1988) suggest that precision is more readily obtained in populations with stable food habits and thus lower within-person variations in nutrient intake. Comparable guidelines are not yet available for children. In general, the 7 days weighed record is widely regarded as the most accurate method of dietary assessment, providing an optimum compromise between compliance and representation of an individual's within person variation in nutrient intake. For specific nutrients longer periods may be necessary, (Marr 1971, Bingham 1987, Bingham 1988, Ralph et al. 1990). When mean grouped dietary data alone is required, 3 days of recording are sufficient (Bingham 1987, Bingham 1988).

Estimated records

Estimated food records are regarded as simpler and less demanding on the subject than weighed records (Marr 1971, Bingham 1987, Nelson 1988, Edington et al. 1989). Instead of weighing food as it is eaten, subjects record an estimated weight in terms of calibrated household measures (Marr 1971, Bingham 1987). Alternative methods of estimating portion size have been developed using photographs (Elwood and Bird 1983), and food models (Cade 1988). In comparison to weighed records the estimated record is less precise, though it is often favoured for large epidemiological studies as a higher degree of co-operation may be achieved and expensive scales are not required (Marr 1971, Bingham 1987, Edington 1989). Bingham (1987) suggests that errors incurred with the estimation of portion weights of food can reach 90% and are regularly in the region of 20 - 50 %. Several studies have compared calculated nutrient intake from an estimated record to that of a weighed record (Cade 1988, Edington et al. 1989, Ralph et al. 1990). Cade (1988) found a difference of less than 10% for all nutrients considered, except fibre and vitamin A in both men and women. Edington et al. (1989) found a correlation of 0.74 for total energy intake, 0.8 for fat and 0.7 for protein, though the records were taken 3-7 months apart. Ralph et al.(1990), in a controlled setting with highly motivated individuals, found the estimated energy intake of the group to average 97% of actual intake, with a tendency to overestimate carbohydrate intake and underestimate fat intake. It is concluded that the estimated intake is less accurate than a weighed intake, but is a simple and sufficiently accurate means of determining the energy and nutrient intake of groups of people (Bingham 1987, Cade 1988, Edington 1989, Ralph 1990).

The 24 hour recall

By interview, the subject is asked to recall and accurately describe all food and drink taken in the previous 24 (or 48) hours. Food models may be used to determine portion sizes. There are many sources of error in this methodology, including the accurate recall of foods eaten the day before and the translation of portion size into a weight. A single 24 hour recall does not take account of the normal within-person variation in daily nutrient intake (Bingham 1987, Loken 1988). The 24 hour recall does have practical advantages, it is quick, simple and inexpensive, places minimal stress on the subject and can be applied to all strata of society. In large scale epidemiological studies it can be a useful pointer to potential dietary problems and has been found to show good agreement with group mean nutrient intake of weighed food records (Loken 1988). The 24 hour recall often forms part of the dietary history.

The diet history.

Bingham (1987) described the origins and form of the diet history. It traditionally takes 3 parts: a 24 - 48 hour recall with a detailed description of the subject's typical food intake, including variations; a 'food intake list' of up to 100 different foods to determine their usual intake, with a system of cross-checks; and finally an account of household food purchases and the distribution of foods among family members. This data is then combined into a list of typical foods and quantities normally eaten by the subject, to be analysed by food tables (Bingham 1987). Today the diet history is seldom used in its original form as it places great stress on the interviewer, though modified versions are commonly used in clinical work when patients cannot be studied at home (Marr 1971, Bingham 1987). Its main advantage is that high cooperation rates may be achieved and it can provide information about previous food habits (Bingham 1987). It is not suitable for subjects who have no regular eating pattern (Haraldsdottir 1988), nor is it suitable for correlating an individual's nutrient intake with clinical or biochemical parameters as the degree of precision is low (Bingham 1987) but can be used to broadly classify individuals according to their nutrient intake (Haraldsdottir 1988).

The food frequency questionnaire.

The food frequency method uses a detailed list of foods and food groups to determine how often items are eaten over a specified period of time. The questionnaire may gather information on portion size or rely on standard food portions to assess nutrient intake. It is often administered by post as a self-completing questionnaire. This method was developed by nutritionists in an attempt to find a simple, cheap and more accurate means, than the 24 hour recall, of assessing a population's usual food intake for epidemiological studies (Haraldsdottir and Van Staveren 1988). In many cases quantitative estimation of their accuracy is not possible and despite their routine use in epidemiology attempts to validate them are sparse (Bingham 1987). Correlation coefficients between questionnaire results and weighed records have been found to range from 0.27 to 0.41 (0.75 for alcohol), opinion varying on the usefulness of such questionnaires in epidemiological research (Bingham 1987).

Sources of error in the use of food tables

Unless foods are chemically analysed all dietary surveys employ food tables to assess nutrient intake. The composition of foods does vary from sample to sample, and different methods for nutrient analysis can account for apparent differences in values between food tables. The most recent and comprehensive food tables available should be employed in nutritional research, as the degree of accuracy of food composition tables influences the accuracy of calculated nutrient intakes (Paul and Southgate 1988). Several studies have been carried out in the UK to examine differences in nutrient intake estimated by calculation from food tables and by chemical analysis, with widely varying results (Stockley 1988). Whilst use of food tables underestimated fat intake by 14% in one study, in comparison to chemical analysis (Stockley et al. 1985), they overestimated it by 25% in another (Roshanai & Sanders 1984). Reasons for these differences may include: differences in method of laboratory analysis of nutrients, missing food and nutrient values in the food tables (particularly relevant in the calculation of individual fatty acid intakes) and loss of, or changes to the nutrient content of the analysed food sample during storage, the manufacturing process or cooking (Stockley 1988).

A significant and often unappreciated source of error in the use of food tables occurs during the coding and calculating stages, due to difficulty in the interpretation of food descriptions, accidentally assigning wrong codes, or mistakes in keying in data to the computer (Bingham 1987).

Validation of diet survey methodology.

The weighed record is used as a means of validating non-weighed diet survey methodology. However, the validity of the weighed intake itself has recently been thrown into doubt by Livingston et al. 1990. They suggest that short-comings in dietary survey methodology may have generated misleading data, contributing to widespread confusion about the impact of diet on health. It is suggested that bias, or non-random error due to underreporting or changes in eating habits, though well-recognised but having unknown magnitude and direction, are the most serious problems in weighed methodology (Livingston et al. 1990). To evaluate the 7 day weighed record, Livingston et al. (1990) compared mean daily energy in-take (DEI) to total daily energy expenditure (TDEE) es-timated concurrently by the doubly labelled water tech-nique (DLW). The principle of the DLW technique is that two isotopes of water ($H_2{}^{18}O$ and $^{2}H_2O$) are administered orally and then their rates of disappearance from body fluid are monitored over 10 - 15 days by analysis of urine samples. The rate of disappearance of $^{2}H_2O$ reflects output of water, whilst that of $H_2{}^{18}O$ reflects output of water plus CO_2. The rate of production of CO_2 is deter-mined from the difference between the two disappearance rates. With knowledge, or an estimation of the respiratory quotient, it is possible to estimate energy expenditure to an accuracy of +/- 5% (Coward 1988, Jequier and Schutz 1988). By comparing DEI to TDEE in 31 adults Livingston et al. (1990) found mean energy intake to be significantly lower than the estimate of energy expenditure in both men and women. On dividing data into thirds of energy intake the ratio of energy intake to energy expenditure was close to 1.0 in the upper third of the results, indicating no significant bias between the two measurements. However for the middle and lower thirds of energy intake the ratios were 0.74 and 0.70 for men and 0.89 and 0.61 for women, indicating significant discrepancies. The overall bias was estimated as being over 20% in 18 subjects and as much as 50% in 3 subjects. Livingston et al. (1990) concluded that the observed discrepancies arose largely from inaccurate estimates of habitual energy intake due to conscious or subconscious changes in normal dietary patterns, or underreporting, or both. They suggest that such bias may exert a powerful effect on regression analysis as the invalid results are at the extremes of the range, giving seriously misleading conclusions in epidemiological studies.

The conclusion drawn from the validation study of Livingston et al. (1990) has been challenged as misleading by Jackson and Wootton (1990). They suggest that if energy expenditure is taken as the independant variable then subjects in the upper third of TDEE had a level of energy expenditure that represented a very high rate of sustained physical work, contributing to the observed discrepancy between energy intake and expenditure. Jackson and Wootton (1990) suggest that the results of Livingston et al. (1990) illustrate the very real problems associated with determining energy intake and expenditure in individuals or populations but think that the basis of the discrepancy needs to be explored much more fully before one or other approach is rejected as being unreliable because it may show significant bias.

The above controversy refers largely to studies of adolescent children and adults and does not necessarily apply to pre-school children (DOH 1991). Recent studies of primary children suggest a much closer correlation between estimates of energy expenditure and energy intake than found in adults (Livingston et al. 1991). The Panel on Dietary Reference Values of COMA were unable to find evidence of a discrepancy between the two methods in young children, as shown among adolescents and adults (DOH 1991).

Estimation of total daily energy expenditure in children by the DLW method includes an allowance for the energy deposited as new tissue. At 24 months of age this factor is actually very small, at only 16 kcal/day (Vasquez-Velasquez 1988).

Biological markers

Independent biological methods for validation of the accuracy of dietary surveys are available (Bingham 1987). These are much less costly than the measurement of energy expenditure, though require a high degree of subject co-operation in the collection of repeated 24 hour urine samples, so are of limited value. Determination of the 24 hour urine nitrogen output, for comparison with protein intake, is the most widely used method of biological validation. This, however, depends on the assumption that subjects are healthy and well-nourished, so in nitrogen balance. The completeness of the urine collection should itself be evaluated by administration of an oral dose of p-aminobenzoic acid (PABA) of which 93% should be recovered in the urine over the 24 hours period (Bingham 1987). Whilst this method has been used in adults, it would be extremely difficult to obtain co-operation and a complete 24 hour urine collection from young children.

SUMMARY

Diseases of affluence, such as heart disease, obesity and cancer are the greatest health problems facing our Western culture. Though the aetiology of such conditions is highly complex, recent consensus suggests that diet influences our predisposition to disease. As a result, dietary guidelines aimed at adults and schoolchildren have been formulated in an attempt to reduce the incidence of disease.

Opinion is divided on the issue of whether dietary guidelines aimed primarily at the prevention of adult diseases should be applied to children under five years of age. Whilst it is recognised that diet in the preschool years greatly influences lifelong eating habits, concern is expressed about the ability of modified low fat/high fibre diets to adequately support growth. Several nutritional studies of pre-school children have been undertaken in the UK over the past 50 years, but none is recent. Though of immense value to our understanding of the nutritional needs of young children they were concerned mainly with the adequacy of diet in relation to undernutrition and they do not relate to the diet and lifestyle of pre-school children today, nor do they provide information with which to evaluate the effects of modified diets on nutritional intake and velocity of growth.

There is therefore a pressing need for comprehensive nutritional and anthropometric information on pre-school children with which to investigate the influence of variation in dietary composition on growth. Such information would greatly assist the formulation of safe and realistic dietary guidelines for the pre-school child and would update the bank of knowledge on which Dietary Reference Values for Food Energy and Nutrients are based.

HYPOTHESIS

Modified diets, aimed at reducing morbidity and mortality in adulthood, do not affect normal growth in pre-school children.

AIMS AND OBJECTIVES.

The aims and objectives of this research were:

To investigate factors influencing the eating habits of pre-school children, by the following means:

(1) Comparing the food intake of pre-school children with family eating habits.

(2) Examining key influences on family eating habits.

(3) Assessing the effect of appetite on energy and nutrient intake.

(4) Determining the use of vitamin and fluoride supplements.

(5) Assessing dental health and hygiene.

(6) Correlating dental habits with sugar intake.

(7) Correlating bowel habits with fibre, sugar and fat intake.

(8) Assessing the self-reported incidence of food allergy in our cohort of children.

To determine the normal range and mean intake of energy and nutrients, for pre-school children aged 2 - 5 years in Edinburgh, by the following means:

(1) Obtaining data on intake of nutrients by means of the 7 day weighed intake technique.

(2) Calculating average daily intake of nutrients by age group and gender.

(3) Comparing intake of nutrients with the current UK Dietary Reference Values for energy and nutrients.

(4) Comparing energy and macronutrient intakes, per kg body weight, by age and gender.

(5) Comparing average daily intake of nutrients by gender and socioeconomic group.

(6) Examining the quality of the diet of pre-school children in comparison to older children and adults by expressing nutrient intake per 1000 kcal.

To investigate how variation in dietary composition may influence nutritional intake, and to determine the relationship between intake of nutrients, by the following means:

(1) Correlation of:

i. Total energy intake with the intake of fat, protein and carbohydrate, expressed as % of energy intake.

ii. Total energy intake with average daily intake of individual nutrients.

iii. The intake of fat, protein and carbohydrates, expressed as % of energy intake, with each other.

iv. The intake of fat, protein and carbohydrates, expressed as % energy intake, with the intake of specific nutrients by weight per 1000 kcal.

v. Intake of specific nutrients, expressed by weight per 1000 kcal, with other specific nutrients expressed by weight per 1000 kcal.

(2) Correlation of the average daily intake of specific nutrients during the first 7 day survey with the corresponding nutrient intake during the second 7 day survey.

To compare parameters of growth in a healthy randomly selected group of pre-school children in Edinburgh to the currently accepted UK standards of growth by the following means:

(1) Collecting anthropometric measures of height, weight, skinfold thicknesses and mid-calf and mid-arm circumferences from a group of pre-school children, for comparison with the accepted UK standards.

(2) Repeating the above measurements one year later in a large proportion of children to obtain growth velocity data.

(3) Correlating anthropometric measurements taken during the first survey with the corresponding anthropometric measurements taken one year later from children who repeated the study.

(4) Comparing parameters of growth between socioeconomic groups.

To assess the influence of variation in dietary composition during early childhood on growth, by the following means:

(1) Correlating growth and growth velocity parameters with:

i. Total energy and nutrient intake.
ii. Intake of macronutrients, expressed as % energy intake.

(2) Examining the growth parameters and diet of children with a low height velocity percentile of <30.

(3) Comparing the growth parameters and nutrient intake of children taking a <u>high fibre diet</u> (top 11% cases) to those taking a <u>low fibre diet</u> (bottom 11% cases).

(4) Comparing the growth parameters and nutrient intake of children taking a <u>low fat diet</u> (<30% energy from fat) to those taking a <u>high fat diet</u> (>40% energy from fat).

(5) Comparing the growth parameters and nutrient intake of children taking a <u>low fibre/high fat diet</u> (<6.5g fibre/ >40% energy from fat) to those taking a <u>high fibre/low fat diet</u> (>13.5g fibre/ <30% energy from fat).

(6) Comparing the growth parameters and nutrient intake of children habitually taking full-fat milk to those habitually taking semi-skimmed milk.

On the basis of the results of the above aims and objectives dietary guidelines for pre-school children will be proposed.

CHAPTER 2 METHODOLOGY

INTRODUCTION

This survey was designed to be undertaken over a three year period from October 1987 to October 1990. It was divided into 3 phases as follows:

6 months planning and preparation

18 - 20 months data collection

10 - 12 months data analysis.

This plan was largely adhered to. (Preliminary results were presented to the Scottish Group of the British Dietetic Association in October 1990.)

Three types of data were collected; weighed dietary, anthropometric and questionnaire.

Ethical approval was obtained from both the Paediatric/Reproductive Medicine Ethics of Medical Research Sub-committee and the General Practice/Community Medicine Ethics of Medical Research Sub-committee of the Lothian Health Board.

SAMPLE SELECTION

The potential sample size to be studied was constrained by the length of time available for data collection and the number of studies that could reasonably expect to be completed per week. Advice was sought from Mrs J. Calder, research dietitian, who had recently completed a dietary study of diabetic children.

Given the above constraints the survey aimed to study 200 children, 60 - 70 children in each of the age ranges 2 - 3, 3 - 4, 4 - 5 year of age. To obtain a sample of 200 children, an experienced research health visitor advised that in view of relatively low response rates, 3 times the required number of children would need to be invited to participate. To this was added a 10% 'safety factor' giving a initial sample size of 675.

The survey also aimed to repeat approximately 100 children after an interval of 12 months to assess the degree of correlation of nutrient intake from the first survey with that of the second survey and to give a measure of growth velocity.

Children were selected from the Lothian Child Health Register, to which access was offered by the Community Child Health Specialists. Computer generated lists were compiled according to a specified postal area and age range. Children were drawn from 6 postal areas of Edinburgh, chosen to provide a mix of socioeconomic backgrounds, while minimising travel distance and time. Four areas were sampled during the first 6 month phase of the study (repeated 12 months later) and two large complementary areas for the second phase. Six to eight times the number of children required were listed, from which children were randomly selected.

The Lothian Child Health Register gave details of the child's date-of-birth, address, general practitioner (GP) and health visitor. After it had been determined which children would be contacted, new lists were compiled by postal area, age and gender to which was added a six digit identification code to be used throughout the study on all subsequent reference material.

Prior to obtaining the computer generated lists of children, the 18 - 20 month data collection period was carefully designed and timetabled. It was split into 3 x 6 month phases, as those children participating in the first six months were to be repeated in the final six months. To provide uniform sampling over the 2 - 5 age group and growth velocity data over as wide an age span as possible, it was decided to split the age range from 2 to 5 years into six month blocks, concentrating on the youngest 24 - 30 month and the oldest 42 - 48 month children during the first 6 months of data collection, from whom growth velocity data would be obtained by repeat survey in the final six months at age 36 - 42 and 54 - 60 months. Children aged between 30 - 36 months and 48 - 54 months were surveyed during the middle six month period of the study. This study design was approved by Dr R. A. Elton, Department of Medical Statistics, University of Edinburgh.

A criteria of obtaining ethical approval for this study was that the GP of each of the 675 children would be informed prior to contacting the mother. GP's were therefore sent a standard letter (appendix 1) informing them of the study and of the children from their practice who had been randomly selected for inclusion. They were asked to identify any children with chronic illness or who for social reasons, or otherwise, should not be included. This process excluded a small number, approx. 5% of the sample.

The mother, or guardian, of each the remaining children was then sent a standard letter of invitation (appendix 1) informing her of the requirements of the study, a standard reply letter and a stamped addressed envelope. Letters of invitation were posted in batches just prior to the period when a group of children would be studied. On receipt of a positive reply the mother was immediately telephoned to arrange a suitable date for the initial appointment. As anticipated the response rate was not high, at 33%, though it varied considerably, with a better response from residential areas having a strong community spirit. Approximately 5% of letters were returned undelivered. As required, over 200 mothers responded favourably to the letter of invitation, though for a variety of reasons, as outlined below, only 153 children successfully completed the first survey.

Details of Sample:

No. of children agreeing to participate:	205
No. of surveys unsuitable for use:	6
No. of withdrawals due to 'difficulty'	6
No. of withdrawals for 'social' reasons	40
	(52)
Sample size of the initial survey:	153

Withdrawal for 'social' reasons included family illness, bereavement, birth of baby, violent burglary, sale of house, unexpected move to a new area and lack of cooperation from the child's nursery or childminder.

80 Children who had successfully completed the survey in the first six - eight months were, on completion, invited to participate one year later. Most mothers happily agreed, though for a variety of social reasons similar to those outlined above many were unable to do so. A total of 54 children repeated the survey.

The final sample size was as follows:

INITIAL SAMPLE	: 153 Children	: 82 girls	: 71 boys.
REPEAT SURVEY	: 54 Children	: 28 girls	: 26 boys.
TOTAL	**: 207 Children**	**: 110 girls**	**: 97 boys.**

WEIGHED DIETARY INFORMATION.

The 7 day weighed inventory method, as first described by Widdowson 1947 was the methodology of choice as a high degree of accuracy was required from individual subjects for correlation of nutrient intake with anthropometric parameters.

20 sets of equipment were prepared to ensure an adequate supply. Each comprised digital scales, bowl and

lightweight plate, an A4 ring binder with instructions and record sheets (record book), notebook and pen.

Instructions: The recording instructions were designed to be detailed, but simple and clear (appendix 1). During the initial 30 minute visit to mothers, the instruction sheets were fully explained and demonstrated. Thereafter they served as a source of reference. They were covered in plastic to allow mothers to select and remove all or individual sheets from the folder as required. In practice, the 'sample menu' was the favoured guide.

Throughout the study mothers were given as much flexibility as possible in methodology to ensure that they felt in control of the situation. Some mothers preferred to use an accumulated weighing technique for all food, as for drinks. Others prepared a daily jug of 'squash' rather than weighing each individual cupful. Such deviations were acceptable providing the necessary information was discernable.

Recording: Mothers were asked to weigh all food and drink for seven days, inclusive of 5 weekdays and one weekend. It was not essential that these days were consecutive. For convenience and to prevent fatigue most mothers split the weighing periods into 2 or 3 day sessions over 2 weeks. A random selection of days is regarded as giving more accurate dietary information, providing the subjects 'usual' eating habits are adhered to (Bingham 1988). The importance of recording the child's 'usual diet' was stressed, including sweets and snacks. In addition to the formal record sheets, a small notebook was provided. Though initially intended as a pocket diary for use out-with the home, most mothers preferred to use it throughout the day, writing up the diary at leisure in the evening. This system worked extremely well, with most mothers proudly presenting a detailed and beautifully written account of their work (Appendix 2).

During the first month of the data collection period mothers were visited on their second day of data recording. It was soon apparent that the vast majority of mothers, irrespective of level of education, found little difficulty in understanding the instruction sheets, recording information or using the scales. For such mothers unnecessary supervisory visits were an intrusion and an inconvenience. Thereafter a flexible approach was taken to the supervision of mothers; most were seen only at the beginning and end of the survey, in the manner of Widdowson (1947). This allowed more time for the supervision of mothers who lacked confidence, had difficulty in reading or understanding the instructions, or who needed gentle 'pressure' to complete the study. A 7 day telephone number was provided and mothers were encouraged to use this for any queries or problems that arose.

The vast majority of children attended a part-time nursery school at which they received a small snack. This was recorded in the child's notebook. A few children attended full-time nursery, receiving a mid-day meal. In such cases it was necessary to visit the nursery to explain the study and seek cooperation. A simple five day chart was provided to record food intake at nursery. Some were happy to weigh food, most gave an estimated weight. If possible the week's menu, standard portion sizes and recipes were obtained from the cook.

The child's food record book was scrutinised at the final home visit. Food descriptions, weights and recipes were carefully checked, giving the mother the opportunity to resolve any final queries she herself had.

Scales. Choice of digital scales for use during the survey was an important issue. They needed to be accurate, weighing preferably in 1g or 2g units, durable, easy to use, not prohibitively expensive, lightweight and portable. As many different types were available a small survey was carried out to test the above criteria and this was subsequently published in the British Dietetic Association Adviser, Spring 1989 (Appendix 4).

The Tefal Microtouch Electronic Scale was chosen as it is compact, easy to use and accurately weighed in 1g units. Twenty sets of scales were purchased and each given an identification number. Before use, and periodically during the data collection period, each set of scales was tested for accuracy using a set of test weights weighing 10g, 100g, 200g, 500g and 1kg (Table 9).

TABLE 9

ACCURACY OF DIGITAL SCALES

SCALE No.		TEST WEIGHT.			
		100g	200g	500g	1000g
1	May '88	99	199	500	999
	Feb '89	Replaced due to fractured casing.			
2	May '88	99	199	500	1002
	May '90	99	200	500	1002
3	May '88	99	201	502	1004
	May '90	100	201	501	1004
4	May '88	100	200	502	1004
	May '90	99	201	501	1003
5	May '88	99	199	501	1003
	May '90	99	200	501	1004
6	May '88	99	200	500	1003
	May '90	99	199	502	1003
7	May '88	100	201	500	1004
	May '90	99	199	502	1004
8	May '88	99	199	503	1007
	May '90	100	200	503	1005
9	May '88	99	199	501	1002
	May '90	99	200	502	1004
10	May '88	99	201	500	1001
	May '90	99	200	501	1004
11	May '88	98	200	501	1002
	May '90	99	200	501	1004
12	May '88	100	200	499	1002
	April'89	Damaged - replaced.			
13	May '88	100	200	501	1002
	May '90	100	201	502	1004
14	May '88	99	200	501	1000
	May '90	100	201	501	1004
15	May '88	100	200	500	1003
	May '90	98	200	502	1003
16	May '88	99	200	502	1002
	May '90	99	199	501	1003
17	May '88	100	200	501	1002
	Oct.'88	Damaged - replaced.			
18	May '88	100	198	502	1001
	May '90	Switch needs repair.			
19	May '88	99	199	500	1003
	Summer '89	Not returned by family.			
20	May '88	101	200	502	1002
	May '91	100	201	502	1002

With a consistent level of error of only 1% at the 100g level and 0.5% at the 1kg level, use of these scales was very satisfactory.

The methodology for the 7-day weighed inventory was pilot tested by four volunteers before the data collection period. This particularly tested the clarity of the instruction sheets and the ability of the rechargeable batteries used in the digital scales to endure 7 days of constant use.

Dietary Analysis. Several computerised versions of the standard UK food tables, 'McCance and Widdowson: The Composition of Foods' by Paul and Southgate (1978), are available. Software packages considered included The Nuffield Nutrition Database (NNDB), Microdiet by Salford University, COMP-EAT by Lifeline Nutritional Services and the as yet unpublished UNIDAP by the Royal Society of Chemistry. All four packages were extensively reviewed, each being found to have characteristic drawbacks and benefits.

NNDB was designed for the study of diet in relation to heart disease. It specialises in giving extensive information on fatty acid composition, including trans fatty acids. Many additional foods, including details of a wide range of cooking oils, margarines and spreads have been added to the database. The main drawback of NNDB is its lack of flexibility in use. Additional foods and recipes cannot be added to the database. Data entry per subject is limited to a list of 110 foods, thus weekly amounts of staple foods need to be summated before being entered.

MICRODIET is a very popular package. It is extremely easy to use and has several useful functions for data manipulation. These include a graphics module for display of nutrient intakes and comparison with Recommended Daily Amounts, calculation of 'sources' of nutrients in the diet and a statistical module to examine average values for groups of individuals. This package had two main drawbacks. Firstly, though the method of data entry is rapid and simple, amounts of individual foods are automatically summed as data entry proceeds. There is no facility for the input of each of the separate 7 days. This system is thus easily subject to error as it is difficult to detect mistakes and omissions. A second drawback to this system is that it did not include 'Milk Products and Eggs' (Holland et al. 1989), the fourth supplement to The Composition of Foods.

UNIDAP has not yet been published. However, the author was invited to review and evaluate this package for The Royal Society of Chemistry. UNIDAP aims to be an advanced and flexible package. It includes unusual features for specialist use in a clinical situation. It was found to be frustratingly difficult to use due to poor software programming, with a laborious method of data entry and error correction, and little data security. Data files could easily be deleted without warning.

Though produced by the Royal Society of Chemistry, the database of UNIDAP did not include the 1988 and 1989 supplements to The Composition of Foods.

The final choice of package was COMP-EAT, largely because it uniquely included the first four supplements to the 1978 food tables (Paul et al. 1980, Tan et al. 1985, Holland et al. 1988, Holland et al. 1989). In a simple manner, new food items and recipes could be added to the COMP-EAT database and assigned identification codes.

In total 100 new foods and 50 recipes were added to the database, including selected items from a supplementary food composition table by Wiles et al. 1980. Food items added to the database included a wide range of fruit juices and soft drinks, frozen convenience foods, confectionery, and some baby foods (Appendix 3). Nutritional information was obtained from manufacturers. Recipes obtained from mothers were calculated from the raw ingredients and, if necessary, corrections made to the fluid content for water losses in cooking (Wiles 1980, Holland et al. 1988). COMP-EAT added the composite recipe to the database as nutrients per 100g food. With access to the database, it was then possible to make corrections to the vitamin content of added recipes, using approximate factors for vitamin losses in cooking given by Paul and Southgate (1978) in the fourth edition of McCance and Widdowson's, The Composition of Foods.

Ideally, the children's food record books would have been coded immediately after collection. In practice this was not possible, hence the need for close scrutiny of the record books for errors before uplifting from mothers. Coding of the record books was a lengthy task, taking on average 1.5 hours per child. Much of this time was spent calculating the weight of foods eaten from the initial weight, minus leftovers.

The data entry system of COMP-EAT was particularly suited to this study. Individual days from a child's 7 day profile could be entered separately then checked for accuracy before proceeding to the next day. This system was time consuming, taking 30 minutes per child, but greatly reduced the degree of error normally attributed to data entry (Stockley 1988). With this system of data entry it was possible to calculate an average daily intake over 7 days, or separately calculate any number or combination of days.

Using the child's unique 6 digit identification number as a filename, the average daily nutrient intake of each child was exported from COMP-EAT into the Supercalc 5 spreadsheet package. A customised 'macro' editing program automatically stripped the nutrient file of unnecessary data and rearranged it into a suitable data file for entry into the statistical software package SPSS PC+.

Values for the intake of micronutrients and trace elements are a reflection of intake during the 7-day study period and do not necessarily reflect habitual mean intake.

ANTHROPOMETRIC MEASUREMENTS.

The necessary anthropometric measurements were determined in consultation with Dr C J H Kelnar, Consultant Paediatric Endocrinologist, Royal Hospital for Sick Children, Edinburgh. Dr Kelnar also provided training in measurement techniques.

For each child height, weight, mid-arm and mid-calf circumferances and triceps and subscapular skinfold thickness were measured.

Height was measured using the methodology of Tanner et al. (1966) as described by Kelnar (1989). A portable 'Microtoise' measuring instrument was used, giving a direct reading of height to the nearest 1mm. With the mother's supervision, and without footwear, the child stood flat on the floor with heels against the wall directly under the microtoise. The child's head was positioned with the external auditory meatus and outer canthus of the eye in the same horizontal plane. The arm of the microtoise was brought down on to the child's head. Gentle upward pressure was applied under the mastoids and the child was asked to breathe in and then out and to relax his shoulders, without lifting heels from the ground. A reading was then taken from the microtoise.

Weight was taken using a portable Salter digital 'Trimscale', weighing in 0.2 kg units. The accuracy of the scale was periodically tested against the frequently calibrated weighing scales in the Royal Hospital for Sick Children, Edinburgh. These scales were found to be extremely accurate providing they were used on a flat hard surface. Children were weighed in light indoor clothing, without footwear.

Mid-arm and mid-calf circumferences were measured on the left side of the body using a flexible metal Harpenden anthropometric tape. With the arm hanging loosely by the child's side, the mid point between the the tip of the acromion and the tip of the olecranon was measured and marked. At this site the arm circumference was measured to the nearest 1mm without allowing the tape to compress the skin. To take the mid-calf measurement the child sat on a firm surface with the lower leg dangling loosely. The mid-point of the calf was where the tape closely encircles the leg, without compression, but can freely move up or down. A reading was taken to the nearest 1mm.

Triceps and sub-scapular skinfold thicknesses were measured with a Holtain skinfold caliper marked in divisions of 0.2mm, by the methodology of Tanner and Whitehouse (1975). A fold of skin and subcutaneous tissue is picked up between the thumb and forefinger, initially placed about 2 cm apart on the skin, and pinching it away from the underlying muscle. Using the right hand, the calipers were applied to the skinfold just under the pinch point and then the grip relaxed to allow the jaws to exert their full pressure. A reading was taken 2 seconds after the calipers were applied. The triceps skinfold was picked up at the mid-arm position as previously marked, over the posterior surface of the triceps muscle on a vertical line passing upwards from the olecranon in the axis of the limb. The subscapular skinfold was picked up just below the angle of the left scapula, in the natural cleavage line of the skin.

All of the above anthropometric measurements were taken in duplicate and a mean value recorded. Occasionally a third reading was necessary. Throughout the data collection period measurements were taken by the author alone on the final visit to the child's home, to reduce the degree of stress likely to be placed on the child. Most children were extremely enthusiastic and cooperative. The height and weight of the parents was also recorded.

For each child the raw anthropometric data was plotted on the appropriate standard growth curve for height and weight (Tanner et al. 1966) and for triceps and sub-scapular skinfold thicknesses (Tanner and Whitehouse 1975) and a percentile value recorded on the data chart to the nearest percentile line, or mid-percentile point, (included as the percentile lines are very far apart).

As there are no UK standard charts for 'weight for height', the percentile value of each child was calculated from the NCHS charts of the USA (WHO document/FAP/79.1).

For the 54 children studied twice it was possible to calculate growth velocity data. Using the KabiVitrum mini growth computer, height velocity, the height velocity standard deviation (SDS) score and the height velocity percentile for each child was calculated, based on the standards of Tanner et al. (1966). The mini computer was also used to calculate the height percentile and SDS score of these children and of their parents.

The anthropometric data record cards were checked for completeness, coded and then entered directly into a suitable data file for analysis by the statistical software package SPSS PC+.

THE QUESTIONNAIRE.

A comprehensive questionnaire was completed on the final visit to the mother. Several categories of information were sought for support of, and correlation with, the dietary and anthropometric data. These categories were: social details, eating behaviour, dental hygiene/health, general behaviour and family eating habits (Appendix 1).

Social details recorded the number of children in the family and the child's own position, the parents level of education, professions, employment status and nationality. The fathers social class was determined by the Registrar General's Classification of Occupations.

Eating behaviour examined table habits, use of eating utensils, parental attitudes and appetite.

Dental hygiene / health enquired about the use of fluoride and vitamin supplements, how often and by whom teeth are cleaned and previous dental treatment. Details of food allergies and bowel habits were also obtained.

General behaviour was designed to assess whether a child could be classified as hyperactive. Advice on this section was sought from a child psychologist.

Family eating habits examined influences on the mother's shopping habits. Also, by use of a simple food frequency questionnaire, in the manner of Abramson et al. (1963), it was possible to compare the child's diet to that of the family, and 'to classify individuals according to their dietary practices rather than according to the amount of specific nutrients in their diet'. Information was obtained on the type of milk used by the child and family, for how long and for what reason.

The time required to complete the questionnaire varied from 20 to 45 minutes, usually including a large portion of 'friendly time', regarded as an important part of the communication process (Cameron and Staveren 1988). In total, the final home visit lasted 1 to 1.5 hours.

On completion of the questionnaire it was coded using a pre-prepared coding schedule (appendix 3). The coded data was then entered directly into a suitable data file for analysis by the statistical software package SPSS PC+.

STATISTICAL ANALYSIS.

The statistical software package SPSS PC+ was chosen as the most suitable tool for the analysis of data. This powerful and versatile package can handle very large amounts of data, as generated by this survey. Two types of files are handled by SPSS PC+. Raw 'data' files, and 'data definition' files to label and identify data. The data definition file for the questionnaire was derived from the coding schedule.

Using SPSS, the 3 data files from each child were reduced to the same format. As each of the 3 files had the same six digit identification code it was possible to merge them into one very large file per child, holding up to 200 variables. Different categories of data could then be correlated. By specifying variable values, such as age, sex, or social class, groups of children could be selected for the analysis of data.

There is no recognised convention for the classification, by age, of groups of pre-school children for dietary analysis. Morgan (1980) states: 'There are no accepted guidelines, each study expresses results differently as clearly shown in the inconsistent age groupings from one survey of pre-school children to another'.

The most suitable method for grouping children in this survey, by age, was that of Widdowson (1947). Throughout, children were classified as age 2 years (24 - 35 months), 3 years (36 - 47 months) or 4 years (48 - 60 months).

STATISTICAL TESTS USED.

1. The following descriptive statistics were used to summarise and display collective results for the intake of nutrients, anthropometric measurements and questionnaire data.

   Frequency, range, minimum and maximum defined the size and boundaries of grouped data.

   The mean was used to define the central tendency of data conforming to a normal distribution. The standard deviation defined the dispersion of data around the mean value.

   For nutrients having frequency distributions that did not conform to a normal distribution, i.e. vitamins A, D, E and C, the median value was quoted to define the central point of the frequency distribution and together with the mean, gave an indication of the direction of skewness of the data.

2. The linear association between sets of data was tested using the correlation procedure.

The Pearson product-moment correlation test was used to test parametric data, such as values for nutrient intakes and anthropometric parameters.

In the case of vitamins A, D, E and C, whose frequency distributions did not conform to a normal distribution, it was necessary to log transform the data to base 10 to achieve a normal distribution, prior to undertaking the Pearson correlation test.

The Spearman ranked correlation test was used to test non-parametric data, such as graded questionnaire data for appetite, and socioeconomic groups. Data for both variables was ranked prior to running the correlation test. This is a more robust test of linear association for non-parametric data than the Pearson test.

3. Two tests of the difference between sub-populations were used, the independent t-test and the Mann-Whitney U test.

The independent t-test was used to compare the means of sub-groups with a sample size of at least 20. This is a more sensitive test for parametric data than the Mann-Whitney U test.

The Mann-Whitney U test was used to test the difference between small sub-populations with a sample size of less than 20. It tests the hypothesis that two independent samples are derived from populations having the same distribution.

A brief introduction to the cohort of 153 children aged 2 to 5 years is provided by Table 10, 'Social details of sample'.

For children studied twice, social details have been extracted from the first survey only.

SOCIAL DETAILS OF SAMPLE.

Only 34 (22%) of the sample were single children, 81 (53%) had one sibling, 32 (21%) had two siblings and the remaining children had up to five siblings. A large proportion of the children, 66 (43%), were first-born, 53 (35%) were second born, 21 (14%) third born and three children were placed 4th, 5th, and 6th in the family. The sample included five sets of twins, comprising two sets of identical girls, one of each non-identical boys and non-identical girls, and one of mixed gender.

The socioeconomic status of the childrens' fathers were spread widely across the socioeconomic spectrum, though were slightly biased towards the non-manual groups when compared to the general population distribution, as obtained from the 1981 Edinburgh census. However, a substantial number of children were from groups IIIM, IV and V, enabling valid comparisons between the groups. The children of single (divorced) mothers were classifed as group V as, for reasons of sensitivity, the occupation of the father was not recorded.

TABLE 10 SOCIAL DETAILS OF SAMPLE (N = 153).

No. of children in family:	N	(% of group)	Position of child in family:	N	(% of group)
One	34	(22)	First	66	(43)
Two	81	(53)	Second	53	(35)
Three	32	(21)	Third	21	(14)
Four	2	(1)	Fourth	1	(1)
Five	3	(2)	Fifth	1	(1)
Six	1	(1)	Six	1	(1)

Fathers Socioeconomic Status.

Socioeconomic group		N	%	Edinburgh census (% 1981)
I	Professional	24	(16)	(8)
II	Intermediate	39	(25)	(21)
IIIN	Non-manual skilled	24	(16)	(13)
IIIM	Manual skilled	38	(25)	(35)
IV	Semi-skilled	11	(7)	(16)
V	Unskilled	2	(1)	(7)
	Unemployed	5	(3)	
	Single mother (unmarried)	3	(2)	
	Single mother (divorced)	7	(5)	

Mothers Socioeconomic Status.

Socioeconomic group		N	(%)
I	Professional	4	(3)
II	Intermediate	54	(35)
IIIN	Non-manual skilled	66	(43)
IIIM	Manual skilled	13	(8)
IV	Semi-skilled	7	(5)
V	Unskilled	9	(6)

If mother works.

	N	(%)
Part-time	49	(32)
Full-time	9	(6)
NO	95	(62)

Parents nationality group:	FATHER N	FATHER (%)	MOTHER N	MOTHER (%)
British	145	(95)	145	(95)
Indian/Pakistan	3	(2)	2	(1)
Algerian/Turkish	5	(3)	2	(1)
Canadian	0	(0)	1	(1)
(Non-UK) European	0	(0)	3	(2)

The socioeconomic status of the mother was recorded according to the level of her professional achievement, whether or not in employment. As indicated, almost 80% of mothers were of the semi-professional (teaching, nursing) or clerical groups. At the time of recording (initial study), only 9 (6%) of mothers were in full-time employment and 49 (32%) part-time, whilst 95 (62%) of mothers were not in employment.

145 (95%) of both mothers and fathers were British, though the parents of eight children were of mixed nationality. The children of non-mixed, non-UK families included 2 Pakistani children and Turkish twins.

INVESTIGATION OF FACTORS INFLUENCING THE EATING HABITS OF PRE-SCHOOL CHILDREN.

Comparison of the type and frequency of food eaten by pre-school children with that of the family.

Table 11 compares the frequency of food intake, classified by food groups, of children aged 2 years, 3 years and 4 years with family eating habits. It is a simple non-quantitative chart, intended as a supplement to the 7 day weighed food intake, providing information on patterns of food consumption.

<u>Milk</u>

There was a perceptible trend in the use of full-fat milk and semi-skimmed milk over the pre-school years.

Full-fat milk was given daily to 70% of 2 year old children but by 4 years was used daily by only 54% of children, on a similar level to family consumption.

Semi-skimmed milk was used daily by only 23% of children at 2 years and at 3 years. By 4 years the number of children using semi-skimmed milk had approached that of the family use.

At 2 years 7% of children were not taking milk on a daily basis, due either to a dislike of milk or milk intolerance. At 3 and 4 years there was a greater tendency for children to take a mixture of types of milk, though most children had a preference for one particular type. Skimmed milk was apparently not used regularly.

TABLE 11

FREQUENCY OF FOOD INTAKE OF CHILDREN AGED 2 YEARS (2), 3 YEARS (3) AND 4 YEARS (4), AND OF THEIR FAMILIES (F).
n=73, n=69, n=75, n=148

	%DAILY				% 2 - 5 x /WK				% WEEKLY				% FORT./MONTH				%RARE/NEVER			
	2	3	4	F	2	3	4	F	2	3	4	F	2	3	4	F	2	3	4	F
FULL-FAT MILK	70	67	54	55	6	16	12	7	1	0	1	1	0	0	0	0	23	17	32	37
SEMI-SKIMMED MILK	23	23	34	40	3	12	9	5	1	0	0	1	1	1	1	1	72	49	57	53
SKIMMED MILK	0	0	0	12	3	1	3	3	0	1	0	0	0	0	0	0	97	99	94	86
PUFA MARG	22	38	37	32	9	7	12	7	1	1	1	1	0	0	0	0	67	54	49	60
TABLE MARG	25	12	20	20	7	9	9	5	7	9	1	8	4	1	5	3	57	70	66	63
LOW FAT SPR.	16	12	18	19	1	4	4	1	0	0	0	0	0	0	0	0	82	84	79	80
BUTTER	27	23	12	28	12	10	11	11	1	6	2	3	1	0	0	1	58	61	65	61
COTTAGE CHEESE	1	0	0	1	4	4	3	4	3	1	1	10	4	4	1	10	88	90	94	75
CHEDDAR CHEESE	20	22	18	23	55	53	65	63	8	10	5	9	0	3	0	2	16	12	12	4
REDUCED FAT CHEESE	0	1	0	1	0	1	1	3	1	0	0	2	3	0	1	1	96	97	97	93
CREAM CHEESE	1	1	5	1	7	1	11	10	4	1	6	4	5	9	5	7	82	87	74	78
EGGS	4	1	0	2	29	17	25	32	22	26	29	33	5	7	8	8	40	48	38	35
RED MEAT	7	7	1	7	75	65	80	80	10	17	9	10	0	3	5	1	8	7	9	2
LIVER/KIDNEY	0	0	0	0	1	0	1	2	4	4	0	5	19	22	10	25	75	74	89	68
MEAT PROD.	1	0	0	1	42	45	36	33	33	29	35	33	11	11	14	15	12	14	15	18
CHICKEN	0	1	0	0	26	22	35	28	41	51	43	44	19	16	19	21	14	10	6	6
WHITE FISH	0	0	1	0	23	20	28	19	45	48	52	52	16	20	6	20	11	12	14	10
OILY FISH	0	0	0	0	0	1	0	1	0	4	1	5	11	10	9	17	89	84	85	78
TINNED FISH	0	1	0	0	5	3	12	8	27	29	23	30	11	19	23	24	56	48	41	38
FRESH/FROZEN VEG.	31	39	32	48	44	38	38	44	7	4	11	5	3	0	0	1	15	19	18	2
TINNED VEGETABLE	3	1	0	2	25	19	18	22	10	10	6	11	5	0	1	3	58	69	74	62
SALAD VEGETABLE	3	9	12	10	22	33	37	41	15	16	17	20	18	20	16	25	42	22	18	4
CHIPS/ROAST POT.	1	0	0	1	38	44	35	39	36	39	31	32	9	6	17	13	15	11	17	15
BOILED/BAKED POT.	15	10	15	13	73	69	61	75	8	7	9	9	0	0	1	0	4	13	13	3
FRESH FRUIT	64	70	68	69	27	24	29	23	4	3	0	2	1	0	0	1	3	3	3	5
PURE FRUIT JCE.	47	32	34	33	11	23	17	21	8	7	8	7	1	1	1	2	33	36	40	37
WHITE BREAD	36	35	43	35	44	38	27	33	1	4	5	4	3	0	1	3	16	23	24	26
WHOLEMEAL BREAD	27	32	37	40	37	42	26	30	1	1	0	1	3	0	1	2	31	25	35	27

Butter and spreads.

Whilst there is controversy about the type of milk that ought to be given to pre-school children there is little comment on the use of butter and spreads, yet trends in patterns of consumption were apparent. The reason for these trends are perhaps more complex, with components of health, economics and 'ease of use'.

At 2 years 22% of children were using PUFA margarine and 27% butter, at 4 years there was a 15% reversal, with 37% of children using PUFA margarine and only 12% using butter. Low fat spread was used daily by 12-18% of children and 12-25% used table margarine.

Families did tend to be quite conservative in their choice of butter or spread, with a large proportion of children and families 'never' using the alternative types. Thus of 'families', 60% never used butter, 80% never used low fat spread, 63% never used table margarine and 60% never used PUFA margarine.

Cheese

There was little difference in cheese consumption with age. Only full-fat cheese, especially cheddar, was popular with young children. At each age it was eaten daily by approximately 20% of children and 2-5 times weekly by a further 53 - 65%. Only 12-16% of children in each group rarely ate cheddar cheese. Cottage cheese and reduced fat cheeses were not popular. Cream cheese, however, was regularly eaten by 12-25% of children.

Eggs (as a meal).

This dietary survey was undertaken during the 'Salmonella scare' of 1989, affecting the popularity of eggs as a food for young children. Many mothers claimed to have markedly reduced their use of eggs for both young children and the family.

Eggs were very rarely given to children on a daily basis, though approximately 20 - 30% of children were taking eggs 2 - 5 times weekly, as were their families. A further 20 - 30% of children and families were eating eggs once weekly. Partly in fear of Salmonella, 35% of families and 38 - 48% of children are reported as never eating eggs.

Meat and Poultry

Although 7-9% of children 'never' ate red meat, there were no vegetarians in this study. It should also be noted that of the children who did eat meat, the contribution to total energy and nutrient intake was extremely small as portion sizes tended to be very small. Red meat provided only 1 - 2% of the mean energy intake of groups of children.

Red meat, i.e. beef, lamb and pork was eaten on a daily basis by up to 7% of children and their families. The majority of children ate red meat 2 - 5 times weekly. At 2 and 3 years of age children were eating red meat a little less often, and meat products a little more often than children at 4 years, or their families.

At 2 and 3 year of age children were eating liver occasionally, though little more than once fortnightly or once monthly. Liver pate was more popular than liver itself.

Meat products were very popular with young children. Though they were not reported as being eaten as often as red meat, they actually provided a higher proportion of energy (3% - 4.5%) than red meat (up to 2%) in children taking both low fat and high fat diets (Table 48).

Poultry, mostly chicken, was not eaten as frequently as red meat or meat products. It was eaten 2 - 3 times weekly by 22-35% of children and once weekly by a further 40 - 50% of children.

Fish

White fish refers to fresh fish and frozen fish fingers. Approximately half of the children ate fish once weekly and a further 20 - 28% ate fish 2 - 5 times weekly. Only 10% of families, and their children, rarely ate white fish. In contrast, oily fish such as herring, trout, mackerel and kipper was rarely eaten by 85 - 90% of the children and 78% of families. Tinned fish, such as tuna and salmon was eaten by approximately 40 - 50% of the children and their families, on a weekly or monthly/ fortnightly basis.

Vegetables, fruit and bread.

One third of children and up to half of their families ate fresh or frozen vegetables on a daily basis. A further 40% approximately, of each group, ate fresh or frozen vegetable 2 - 5 times weekly. A significant proportion of children (15 - 20%) never ate fresh/frozen vegetables.

Tinned vegetables, such as peas, carrots and sweetcorn were frequently eaten as an alternative to vegetables by 30-40% of children and their families. (Baked beans and 'spaghetti hoops' were excluded from this category).

There was a clear trend in the frequency of consumption of salad vegetables with age in pre-school children. Very few young children ate salad e.g. tomato, cucumber, lettuce, on a daily basis. At 2 years salad was eaten 2 - 5 times weekly by only 22% of children, rising to 37% of children at 4 years, almost on par with family consumption. At 2 years 42% of children never ate salad vegetables, dropping by half to 18% at four years. Thus a liking or salad vegetables appears to develop with maturity over the pre-school years.

Patterns of chip consumption were similar across the age range into adulthood. Only 15% of children and families said that they rarely ate chips. Approximately 40% of children and families ate chips 2 - 5 times weekly, and a further 30 - 40% ate chips once weekly. There was no correlation of chip consumption with socioeconomic group. Boiled and baked potatoes were eaten by 97% of familes. 10 - 15% of children and families ate potato daily, 60 - 75% ate potato 2 - 5 times weekly, and 7 - 9% once weekly.

A high proportion of children and families (64 - 70%) reported eating fresh fruit on a daily basis, with a further 23- 30% eating fresh fruit 2 - 5 times weekly. Only 3% of children rarely ate fresh fruit.

Intake of fresh/pure fruit juice was divided between children who drank fruit juice on a daily basis (32 - 47%) or 2 - 5 times weekly (11 - 23%), and those who rarely drank pure fruit juice (33 - 40%). Pure fruit juice was regarded by many mothers as an expensive luxury item.

Preference for white bread or wholemeal/brown bread was equally divided among families, though children tend to prefer white bread. 35% of families and their children ate white bread on a daily basis whilst 26% of families never ate white bread. 40% of families and their children ate wholemeal/brown bread on a daily basis, whilst 27% of families never ate wholemeal/brown bread. The remaining families and children ate a mixture of different types of bread.

Factors influencing mothers choice of food.

Table 12 suggests that the most prevalent influence on the mothers choice of food (apart from family likes and

TABLE 12

FACTORS INFLUENCING MOTHERS CHOICE OF FOOD (N = 153).

	YES (%)	NO (%)	SOMETIMES (%)
Cost of food:	57 (37)	40 (26)	56 (37)
Assessibility of shops:	39 (25)	94 (61)	20 (13)
Ease of preparation:	46 (30)	72 (47)	35 (23)
Television adverts:	10 (6)	128 (84)	15 (10)
Concern about nutrition:	95 (62)	21 (14)	37 (24)

TABLE 13

FACTORS INFLUENCING CHILDRENS EATING HABITS.

Use of table at meal times:	N	(% of group)
Breakfast only	1	(1)
Lunch only	2	(1)
Tea/dinner only	12	(8)
Breakfast & tea	9	(6)
Lunch & tea	12	(8)
All meals	102	(67)
Rarely/Never	15	(10)
	153	100

Meals/snacks eaten whilst watching television:

	N	(% of group)
Breakfast and/or lunch:	32	(21)
Breakfast or lunch & tea:	10	(7)
Tea only:	21	(14)
Between meal snacks only:	25	(16)
All meals & snacks	19	(12)
Rarely/Never	46	(30)
	153	100

TABLE 13 (CONTINUED)

FACTORS INFLUENCING CHILDRENS EATING HABITS.

	AGE (years) (% of group)		
	2 (%)	3 (%)	4 (%)
If child eats family meals:			
Yes - most family meals	61 (84)	56 (81)	52 (80)
The children differ from adults	3 (4)	4 (6)	10 (15)
Eats half of family meals	5 (6)	3 (4)	1 (1)
Eats separately prepared food	4 (5)	6 (9)	2 (3)
	73 (100)	69(100)	65(100)

	2 (%)	3 (%)	4 (%)
Preferred eating utensils:			
Fingers	3 (4)	1 (1)	1 (1)
Fingers & spoon	7 (10)	7 (10)	2 (3)
Spoon alone	9 (12)	7 (10)	2 (3)
Spoon & fork	19 (26)	14 (20)	7 (11)
Fork alone	15 (20)	14 (20)	18 (28)
Knife and fork	4 (5)	8 (12)	22 (34)
Fork & fingers	16 (22)	18 (26)	13 (20)
	73 (100)	69(100)	65(100)

	2 (%)	3 (%)	4 (%)
Preferred drinking utensil:			
Bottle	6 (8)	0 (0)	0 (0)
Feeding cup with spout	34 (47)	12 (18)	5 (08)
Plastic cup/tumbler	19 (26)	19 (27)	22 (34)
Adult cup	14 (19)	38 (54)	38 (59)
	73 (100)	69(100)	65(100)

dislikes) was concern about nutrition, cited by 62% as important.

Cost of food was the regular concern of 37% of mothers and an occasional consideration of a further 37%. Buying food was not a major problem for 61% of mothers, though for 25% of mothers accessibility of shops, even in the city of Edinburgh, influenced choice of food.

Surprisingly, in a society often portrayed as being orientated towards convenience, almost half of the mothers (47%) did not regard ease of preparation of food as a problem, being happy to spend time in the kitchen.

Few mothers (only 6%) would admit to being influenced by television adverts in their choice of food.

Factors influencing childrens eating habits

Table 13 outlines the reported drinking and eating habits of children age 2 to 5 years.

<u>Use of table at mealtimes</u>

Most of the children in this study (67%) sat at a table for all meals. However, 15 children (10%) were unfamiliar with traditional eating habits, rarely sitting at a table to eat. This is a surprisingly high proportion. The remaining children only ate main meals sitting at a table.

Meals/snacks eaten whilst watching television

The reliability of this information is doubtful. In most households the television appeared to be a permanent background feature. It was not uncommon for mothers to say that their children 'never' ate meals or snacks whilst watching television, yet the television was always switched on during visits. Thus children probably eat meals and snacks whilst watching television more often than is admitted by mothers. Mothers did not seem to regard the television as a negative distraction to eating, on the contrary, fussy children were often described as less difficult to please with a tendency to eat more.

Children eating family meals.

At age 2, 3 and 4 years 80% of children were eating meals prepared for the whole family. In only a small proportion of cases was a child eating separately prepared food on a regular basis. In some families the children ate together separately, and usually earlier, than their parents.

Preferred eating utensils. (for main meals).

At 2 years the preferred eating utensils were spoon & fork (26%), fork (20%), and fork & fingers (22%). At four years the preferred eating utensils were fork (28%), knife and fork (34%) and fork & fingers (20%).

Preferred drinking utensil.

At 2 years a small number of children were still drinking from a bottle, most were using a plastic cup with spout or a plastic cup/tumbler. At 4 years almost 60% of children used an adult cup for drinking, the remainder using plastic cups/tumblers.

Classification of appetite and comparison with energy intake, nutrient intake and anthropometric parameters.

Children were categorised and ranked according to their mothers chosen description of their appetite (Table 14). Children with a good appetite who were not fussy eaters were ranked 1, and those at the opposite extreme who had a poor appetite and were fussy eaters were ranked 7. As only 54% of children fell into category 1, the remaining 46% of children, almost half, were in some respect described as poor eaters by their mothers.

Correlation of appetite with nutrient intake and anthropometric parameters is given separately for boys and girls.

Coefficients of correlation tend to be negative for both nutrient intake and growth with ranked appetite, suggesting that poor appetite indeed had a negative effect. In boys, but not girls, many correlations reached levels of significance.

Interestingly, in boys intake of energy had a negative correlation of -0.32 with ranked appetite, as had

TABLE 14

CLASSIFICATION OF APPETITE AND COMPARISON WITH ENERGY INTAKE, NUTRIENT INTAKE AND ANTHROPOMETRIC PARAMETERS.

RANK	CATEGORY	N	(%)
1	Good appetite, not fussy.	82	(54)
2	Good appetite, fussy.	16	(10)
3	Appetite varies, not fussy.	22	(14)
4	Appetite varies, fussy.	14	(9)
5	Poor appetite, not fussy.	6	(4)
6	Poor appetite, mother familiar with likes and dislikes.	1	(1)
7	Poor appetite, fussy eater.	12	(8)
		153	100

Spearman Rank Correlation of appetite with:

	BOYS (N = 71)	GIRLS (N = 82)
	R	R
Mean energy intake	-.319 *	-.175 NS
% energy from fat	.231 NS	-.241 NS
% energy from sugar	.149 NS	.218 NS
% energy from starch	-.252 NS	-.132 NS
Mean fibre intake(g)	-.390 **	-.137 NS
P:S ratio	-.137 NS	.042 NS
Vitamin B1 (mg/day)	-.439 **	-.252 NS
Vit.B1 (mg/1000 kcal)	-.276 *	-.107 NS
Vitamin B2 (mg/day)	-.162 NS	-.108 NS
Vitamin A (ret.eq./d)	-.129 NS	-.212 NS
Vitamin C (mg/day)	-.211 NS	.034 NS
Iron (mg/day)	-.389 **	-.217 NS
Iron (mg/1000kcal)	-.260 NS	-.143 NS
Height	-.319 *	-.127 NS
Weight	-.385 **	-.268 NS
Calf circumference	-.169 NS	-.238 NS
Sub-scapular skinfold	-.263 NS	-.236 NS

* P < 0.01 ** P < 0.001 1-tailed significance

NS = not significant.

height i.e. those with the best appetite had greater energy intakes and greater growth in height and weight. This may be interpreted as appetite affecting energy intake, and thus growth; or alternatively, mothers may have higher expectations of boys than girls, labelling small boys with relatively low energy requirements as 'poor eaters'.

In boys, appetite as ranked, was negatively correlated with intake of vitamin B1, fibre and iron ($P < 0.001$). Not only the quantity, but quality of diet was affected, appetite having a negative correlation with vitamin B1 intake per 1000 kcal ($P<0.01$). In summary, a good appetite in boys does seem to increase intake of fibre, iron and vitamin B1.

Conclusion

It appears that a mother's perception of her child's 'appetite' can be a useful tool in the assessment of the adequacy and quality of a child's diet.

Frequency of use of fluoride and vitamin supplements.

The reported use of fluoride and vitamin supplements by children is shown in Table 15.

Fluoride

Although Edinburgh is a non-fluoridated soft water area, at 2 years of age only one third of the children were regularly taking a fluoride supplement. Some mothers said that they had been advised against giving fluoride by

TABLE 15

FREQUENCY OF USE OF FLUORIDE AND VITAMIN SUPPLEMENTS.

FLUORIDE	2 YRS (%)	3 YRS (%)	4 YRS (%)
YES	24 (33)	29 (42)	36 (55)
NO	46 (63)	38 (55)	43 (44)
SOMETIMES	3 (4)	2 (3)	1 (1)
	73 (100)	69 (100)	65 (100)

VITAMINS	2 YRS (%)	3 YRS (%)	4 YRS (%)
YES	16 (22)	18 (26)	15 (23)
NO	53 (73)	45 (65)	40 (62)
SOMETIMES	2 (3)	4 (6)	5 (8)
WINTER ONLY	2 (3)	2 (3)	5 (8)
	73 (100)	69 (100)	65 (100)

TYPE OF VITAMIN PREPARTION	2 YRS (%)	3 YRS (%)	4 YRS (%)
DEPT. OF HEALTH	9 (12)	11 (16)	7 (11)
COMMERCIAL	11 (15)	13 (19)	17 (26)
NONE	53 (73)	45 (65)	40 (62)
	73 (100)	69 (100)	65 (100)

their dentist as a fluoride toothpaste is used; a few had never heard of fluoride. At 4 years of age 55% of children were taking fluoride, this increase was largely because many children were given fluoride at their nursery.

Vitamins

The number of children who received vitamin supplements was low. Only 22% of 2 year olds, 26% of 3 year olds and 23% of 4 year old children were regularly taking added vitamins. Inexpensive vitamin drops are available from health centres for all children under five years, but few children, only 11% - 15%, received these. Surprisingly, commercial vitamin drops were given more often to 4 year old children than to younger 2 and 3 year old children.

Dental health and hygiene.

Table 16 outlines the level of dental care by children in the study and of dental treatments received.

From the age of 2 years most children were cleaning their teeth regularly each day. In each age group, however, there was a small proportion of children (6 - 8%) who did not clean their teeth daily. Whilst most children cleaned their teeth, from the early age of 2 years a large proportion of children (36%) were doing so without the assistance of a parent.

By the age of 4 years most children (88%) had attended a dentist. The time span between dental visits varied from area to area, most children attending once

TABLE 16

DENTAL HEALTH AND HYGIENE.

		AGE (years) (% of group)		
If teeth are cleaned daily:		2 (%)	3 (%)	4 (%)
	YES	67 (92)	65 (94)	61 (94)
	NO	6 (8)	4 (6)	4 (6)
		73 (100)	69 (100)	65 (100)
Who cleans teeth:		2 (%)	3 (%)	4 (%)
	Parent	10 (14)	10 (14)	7 (11)
	Child	26 (36)	28 (41)	32 (49)
	Jointly	37 (50)	31 (45)	26 (40)
		73 (100)	69 (100)	65 (100)
Number of total dental visits:		2 (%)	3 (%)	4 (%)
	None	31 (42)	17 (25)	8 (12)
	1	21 (29)	13 (19)	8 (12)
	2	13 (18)	12 (17)	4 (6)
	3	4 (5)	9 (13)	8 (12)
	4+	4 (5)	18 (26)	37 (57)
		73 (100)	69 (100)	65 (99)
Months between dental visits:		2 (%)	3 (%)	4 (%)
	N/A	52 (71)	30 (44)	13 (20)
	3	0 (0)	0 (0)	5 (8)
	4+	8 (11)	5 (7)	13 (20)
	6+	12 (16)	30 (44)	31 (48)
	12+	1 (1)	4 (6)	3 (4)
		73 (100)	69 (100)	65 (100)
Any dental treatment:		2 (%)	3 (%)	4 (%)
	YES	2 (3)	4 (6)	11 (17)
	NO	71 (97)	65 (94)	54 (83)
		73 (100)	69 (100)	65 (100)
Type of treatment:		2 (%)	3 (%)	4 (%)
Fillings	1	0 (0)	2 (3)	4 (6)
	2	0 (0)	0 (0)	1 (1)
	3	0 (0)	0 (0)	3 (5)
	5+	0 (0)	0 (0)	1 (1)
Special treatments		1 (1)	0 (0)	1 (1)
Accidental damage		0 (0)	1 (1)	0 (0)
Affected by poor health		0 (0)	1 (1)	0 (0)
Extractions		1 (1)	0 (0)	1 (1)
No treatment		71 (97)	65 (94)	54 (83)
		73 (100)	69 (100)	65(100)

every 6 months, or more often. At two years only two children had received dental treatment, one a special treatment for decay and the other extractions. In both cases drinking sweet juice from a bottle was the cause of decay. At 3 years of age two children had had extractions for decay, one due to accidental damage and one related to medication. At four years of age the number of children with fillings was increasing rapidly; 17% of children having had some form of treatment.

The relationship of dental treatment to intake of energy, fat, sugar and fibre.

Dental treatment was ranked according to severity of decay (Table 17). 'Special treatment' refers to a coating for multiple decay that two children had received to avoid extraction.

This survey provides no scientific evidence that sugar was the cause of dental decay in any of the children. There were no significant correlations of nutrient intake, sugar or otherwise, with dental decay. This is perhaps because mothers of children in receipt of dental treatment had become very conscious of the relationship between sugar and dental decay, and tended to avoid giving their children excess sugar.

TABLE 17

CLASSIFICATION OF DENTAL TREATMENT AND COMPARISON WITH ENERGY, FAT, SUGAR AND FIBRE INTAKE.

RANK	CATEGORY	N	(%)
0	No treatment	144	94
1	One filling	2	1
2	Two fillings	0	0
3	Three fillings	3	2
4	Four fillings	0	0
5	5+ fillings	1	1
6	Special treatments	2	1
7	Extractions	1	1
		153	100

Spearman Rank Correlation of treatment with:

	BOYS (N = 71) R	GIRLS (N = 82) R
Mean energy intake	-.079 NS	-.132 NS
% energy from fat	-.245 NS	-.178 NS
% energy from sugar	-.233 NS	.097 NS
Mean fibre intake(g)	-.151 NS	.123 NS

TABLE 18

CLASSIFICATION OF BOWEL HABITS (FREQUENCY OF PASSING STOOL) AND COMPARISON WITH ENERGY, FIBRE, SUGAR AND FAT INTAKE.

RANK	CATEGORY	N	(%)
1	More than once daily	27	(18)
2	Once daily	111	(72)
3	Every two or three days	12	(8)
4	Don't know	3	(2)
		153	100

Spearman Rank Correlation of bowel habits with:

	BOYS (N = 71)	GIRLS (N = 82)
Mean energy intake	-.156 NS	-.072 NS
% energy from fat	-.026 NS	-.221 NS
% energy from sugar	.006 NS	-.033 NS
Mean fibre intake(g)	.161 NS	-.065 NS

NS = not significant.

Comparison of bowel habits with energy, fibre, sugar and fat intake.

Dietary habits are often linked to bowel habits in children, especially intake of fibre, sugar and fat.

Table 18 categories bowel habits according to frequency of motion.

The majority of children (72%) regularly passed a stool once daily, some children (18%) more frequently than this. No child was regularly constipated although 8% passed a stool only once every 2 or 3 days.

As there were no significant correlations of bowel habits with nutrient intake, neither low fat, high sugar or high fibre diets were related to a higher frequency of motion.

Assessment of the incidence of self-reported food allergy in the group of 153 children.

There was a high incidence of food allergy in this small group of 153 children (Table 19). Of the 12 children (8%) who reported food allergy, 5 (3%) had been diagnosed by their G.P.s as allergic to milk or milk products. Six children reported allergy to a combination of foods and five reported a combination of symptoms.

Milk, milk products and eggs were the most commonly cited foods causing allergy, with symptoms of eczema and asthma. Other foods, such as fish, oranges, peanut butter

TABLE 19

ASSESSMENT OF THE INCIDENCE OF SELF-REPORTED FOOD ALLERGY IN THE GROUP OF 153 CHILDREN.

Frequency of allergy/intolerance:

	N	(% of group)
YES *	12	(8)
NO	138	(90)
POSSIBLY	3	(2)

If diagnosed by G.P:

* yes 5 (3%)
no 7 (5%)

No. of children allergic to:

	N	(% of group)
Milk and Milk products	5	(3.4)
Whole egg	2	(1.3)
Egg white	2	(1.3)
Fish	2	(1.3)
Oranges	2	(1.3)
Orange squash	1	(0.7)
Azo dyes	1	(0.7)
Peanut butter	1	(0.7)
Sultanas	1	(0.7)
Milk chocolate	1	(0.7)
Liquorice	1	(0.7)
Marrow	1	(0.7)

NOTE: Six children reported allergy to a combination of foods.

Symptoms of allergy:

	N	(% of group)
Urticarial rash	5	(4)
Eczema	5	(4)
Asthma	1	(1)
Vomiting/nausea	2	(1)
Watery eyes/runny nose	2	(1)
Hyperactivity	3	(2)

NOTE: Five children reported a combination of symptoms.

Action taken to control food allergy/intolerance:

	N	(% of group)
Avoidance	7	(4)
Cut down intake	1	(1)
Advice from a: Dietitian,	3	(2)
Health Visitor or G.P.	2	(1)

and chocolate were reported to cause urticarial rash, vomiting and watery eyes/nose, all typical symptoms of hypersensitivity.

Three mothers self-diagnosed 'hyperactivity' in their children in relation to food colours, orange squash and oranges.

The five children who had been diagnosed as allergic to milk and milk products by their G.P.s had all received some degree of professional advice about diet. Only one child was adhering to a strictly milk-free diet.

Children allergic to other foods, including eggs, had received no professional advice, but attempted to avoid the foods that they believed caused offence.

DETERMINATION OF THE NORMAL RANGE AND MEAN INTAKE OF ENERGY AND NUTRIENTS FOR PRE-SCHOOL CHILDREN AGED 2 - 5 YEARS.

Intake of energy and nutrients by age group and gender, with comparison to Dietary Reference Values.

A consolidation of the mean group results for energy and nutrient intakes of children aged 2 - 5 years are presented in Tables 20 and 21 'Mean nutrient intake, by age of pre-school girls/boys'.

Comparison of the mean energy and nutrient intakes to Dietary Reference Values (DOH 1991), are shown in Table 22 and a summary of sources of energy intake, by age and sex, is given in Table 23.

Table 24 outlines the main food sources of macro-nutrients of children taking extremely high intakes.

The aim of this section is to draw together data for individual nutrients from these tables.

The following terminology is employed in discussing the results, as defined by the Department of Health (1991).

Estimated Average Requirement (EAR) - estimate of the average requirement, or need, for food energy or a nutrient.

TABLE 20 MEAN DAILY NUTRIENT INTAKE, BY AGE, OF PRE-SCHOOL GIRLS

NUTRIENT	GIRLS 2 YEARS (mean 31 months)	GIRLS 3 YEARS (mean 42 months)	GIRLS 4 YEARS (mean 54 months)
	N = 42	N = 38	N = 30
	MEAN (SD)	MEAN (SD)	MEAN (SD)
ENERGY (kcal)	1045 (198)	1132 (170)	1204 (211)
ENERGY (kJ)	4390 (830)	4757 (714)	5062 (885)
PROTEIN (g)	32.9 (7.9)	34.9 (7.0)	38.6 (9.9)
FAT (g)	41.2 (10.1)	44.7 (8.2)	48.9 (13.8)
TOTAL PUFA (g)*	4.1 (1.3)	5.4 (1.5)	5.7 (2.4)
TOTAL MUFA (g)*	12.8 (3.4)	13.6 (2.7)	15.3 (4.5)
TOTAL SFA (g)*	18.4 (5.5)	18.7 (4.4)	20.5 (6.6)
CHOLESTEROL (mg)*	109.6 (55.0)	97.3 (40.9)	117.0 (47.5)
CARBOHYDRATE (g)	144.6 (32.5)	156.7 (28.6)	161.8 (24.8)
TOTAL SUGAR (g)	87.7 (28.0)	90.4 (23.4)	91.0 (19.9)
STARCH & DEXTRIN (g)	53.1 (12.7)	62.9 (13.6)	66.7 (15.6)
FIBRE (g)	8.3 (2.4)	9.9 (2.5)	10.3 (2.5)
CALCIUM (mg)	576.9 (213.6)	564.7 (220.6)	609.1 (216.2)
MAGNESIUM (mg)	124.1 (26.0)	131.0 (30.8)	147.1 (31.0)
IRON (mg)	5.1 (1.2)	6.1 (1.7)	6.5 (1.3)
COPPER (mg)	0.55 (0.13)	0.61 (0.14)	0.68 (0.14)
ZINC (mg)	3.9 (1.0)	4.0 (1.0)	4.8 (1.3)
SELENIUM (mcg)	14.1 (4.5)	13.9 (5.1)	15.9 (8.7)
CAROTENE (mcg)	990.1 (833)	1046.7 (819)	1348.3 (1003)
RETINOL (mcg)	294.6 (193)	245.2 (187)	272.4 (136)
VITAMIN A (ret. eq. mcg)	455.7 (222)	431.7 (233)	483.6 (260)
VITAMIN D (mcg)	0.89 (0.39)	1.11 (0.60)	1.53 (1.26)
VITAMIN E (a-T-eq. mg)	2.37 (0.80)	2.96 (0.83)	3.34 (1.27)
THIAMIN (mg)	0.59 (0.13)	0.62 (0.15)	0.71 (0.18)
RIBOFLAVIN (mg)	1.15 (0.4)	1.15 (0.5)	1.22 (0.4)
NICOTINIC ACID (mg)	7.0 (2.2)	8.4 (2.7)	8.8 (2.5)
TRYPTOPHAN (mg)	20.5 (16.1)	25.9 (22.8)	34.4 (24.8)
NICOTINIC ACID EQ. (mg)	8.5 (2.6)	10.3 (3.2)	11.0 (3.1)
VITAMIN B_6 (mg)	0.89 (0.23)	1.00 (0.29)	1.02 (0.26)
VITAMIN B_{12} (mcg)	2.40 (1.01)	2.48 (1.07)	2.50 (1.02)
FREE FOLIC ACID (mcg)	20.3 (11.0)	20.2 (8.8)	25.7 (8.8)
TOTAL FOLIC ACID (mcg)	97.2 (26.7)	102.9 (32.8)	113.0 (30.9)
PANTOTHENIC ACID (mg)	1.98 (0.70)	1.86 (0.61)	2.21 (0.63)
BIOTIN (mcg)	11.0 (4.6)	10.2 (4.0)	12.5 (5.1)
VITAMIN C (mg)	46.0 (39.4)	37.6 (32.4)	52.9 (40.6)
% ENERGY FROM FAT	35.5 (4.6)	35.6 (4.2)	36.0 (5.4)
% ENERGY FROM MUFA*	11.1 (1.9)	10.9 (1.8)	11.3 (1.8)
% ENERGY FROM PUFA*	3.5 (0.9)	4.3 (1.1)	4.2 (1.6)
% ENERGY FROM SFA *	15.8 (3.0)	14.9 (2.6)	15.0 (2.8)
% ENERGY FROM CARBOHYDRATE	51.9 (5.7)	51.9 (4.6)	51.0 (6.0)
% ENERGY FORM STARCH & DEXTRIN	19.3 (4.2)	21.0 (4.1)	20.8 (3.9)
% ENERGY FROM SUGAR	31.2 (6.4)	29.8 (5.5)	28.9 (6.6)
% ENERGY FROM PROTEIN	12.6 (1.9)	12.3 (1.4)	12.8 (1.6)
PUFA:SFA RATIO	0.23 (0.08)	0.30 (0.09)	0.29 (0.12)

NOTE * slight underestimation as nutrient database incomplete.

TABLE 21 MEAN DAILY NUTRIENT INTAKE, BY AGE, OF PRE-SCHOOL BOYS.

NUTRIENT	BOYS 2 YEARS (mean 30 months)	BOYS 3 YEARS (mean 43 months)	BOYS 4 YEARS (mean 54 months)
	N = 31	N = 31	N = 35
	MEAN (SD)	MEAN (SD)	MEAN (SD)
ENERGY (kcal)	1071 (179)	1191 (212)	1260 (188)
ENERGY (kJ)	4504 (755)	5009 (888)	5300 (790)
PROTEIN (g)	33.4 (7.1)	38.1 (10.7)	39.3 (7.1)
FAT (g)	41.7 (9.1)	45.7 (12.0)	48.1 (9.1)
TOTAL PUFA (g)*	4.6 (1.7)	5.7 (2.0)	5.7 (1.6)
TOTAL MUFA (g)*	13.0 (3.5)	13.7 (4.0)	14.5 (3.2)
TOTAL SFA (g)*	18.0 (4.2)	18.8 (5.4)	20.1 (5.2)
CHOLESTEROL (mg)*	111.0 (54.6)	110.2 (46.6)	113.4 (49.5)
CARBOHYDRATE (g)	149.9 (34.1)	167.4 (25.7)	178.5 (32.3)
TOTAL SUGAR (g)	84.8 (26.5)	91.4 (18.9)	98.4 (27.4)
STARCH & DEXTRIN (g)	60.4 (19.6)	72.2 (15.8)	76.8 (14.5)
FIBRE (g)	9.7 (3.0)	11.2 (3.0)	11.2 (2.8)
CALCIUM (mg)	583.6 (169.9)	620.3 (241.1)	648.4 (180.3)
MAGNESIUM (mg)	133.9 (31.4)	153.3 (37.3)	150.2 (31.8)
IRON (mg)	5.6 (1.5)	6.5 (1.8)	7.1 (2.1)
COPPER (mg)	0.61 (0.20)	0.60 (0.24)	0.63 (0.19)
ZINC (mg)	4.1 (0.8)	4.7 (1.4)	4.9 (1.0)
SELENIUM (mcg)	14.3 (6.4)	18.3 (7.7)	18.1 (7.8)
CAROTENE (mcg)	743.9 (534)	1124.5 (702)	1144.2 (1002)
RETINOL (mcg)	352.5 (399)	320.4 (202)	288.9 (168)
VITAMIN A (ret. eq. mcg)	465.9 (397)	509.8 (262)	490.1 (284)
VITAMIN D (mcg)	1.12 (0.63)	1.22 (0.67)	1.44 (0.58)
VITAMIN E (a-T-eq. mg)	2.60 (0.92)	2.89 (0.80)	3.02 (1.11)
THIAMIN (mg)	0.61 (0.15)	0.74 (0.19)	0.80 (0.18)
RIBOFLAVIN (mg)	1.18 (0.37)	1.25 (0.37)	1.41 (0.50)
NICOTINIC ACID (mg)	7.1 (2.6)	9.0 (2.8)	9.95 (2.98)
TRYPTOPHAN (mg)	21.5 (19.0)	25.3 (16.8)	26.8 (15.7)
NICOTINIC ACID EQ. (mg)	9.0 (3.4)	11.0 (3.7)	11.8 (3.6)
VITAMIN B_6 (mg)	0.88 (0.28)	1.02 (0.30)	1.13 (0.30)
VITAMIN B_{12} (mcg)	2.58 (1.74)	2.65 (1.30)	2.65 (0.75)
FREE FOLIC ACID (mcg)	20.5 (10.9)	25.7 (11.0)	23.8 (10.73)
TOTAL FOLIC ACID (mcg)	94.7 (26.2)	116.4 (31.0)	129.5 (38.0)
PANTOTHENIC ACID (mg)	2.01 (0.59)	2.24 (0.74)	2.26 (0.59)
BIOTIN (mcg)	11.8 (4.0)	12.6 (4.5)	12.57 (3.88)
VITAMIN C (mg)	33.7 (33.0)	43.7 (31.8)	43.7 (37.3)
% ENERGY FROM FAT	35.1 (5.4)	34.3 (3.7)	34.4 (4.0)
% ENERGY FROM MUFA*	10.9 (2.2)	10.2 (1.5)	10.4 (1.8)
% ENERGY FROM PUFA*	3.8 (1.1)	4.3 (1.3)	4.1 (1.1)
% ENERGY FROM SFA *	15.2 (3.3)	14.1 (2.5)	14.3 (2.6)
% ENERGY FROM CARBOHYDRATE	52.2 (6.3)	53.0 (4.7)	53.1 (4.9)
% ENERGY FORM STARCH & DEXTRIN	21.1 (5.7)	22.9 (4.2)	22.9 (3.6)
% ENERGY FROM SUGAR	29.5 (7.2)	29.1 (5.1)	29.2 (5.7)
% ENERGY FROM PROTEIN	12.6 (2.3)	12.7 (2.0)	12.5 (1.6)
PUFA:SFA RATIO	0.27 (0.10)	0.32 (0.14)	0.30 (0.12)

NOTE * slight underestimation as nutrient database incomplete.

TABLE 22

COMPARISON OF MEAN DAILY NUTRIENT INTAKES WITH ESTIMATED AVERAGE REQUIREMENTS (EAR) FOR ENERGY AND REFERENCE NUTRIENT INTAKES (RNI) FOR PROTEIN AND SELECTED VITAMINS AND MINERALS[1].

ENERGY (kcal/day).

GIRLS	MEAN	(SD)	(% EAR)	MIN.	(% EAR)	MAX.	(% EAR)	EAR
2 yrs	1045	(198)	(85)	708	(58)	1476	(120)	1230
3 yrs	1132	(170)	(83)	689	(50)	1462	(107)	1370
4 yrs	1204	(211)	(82)	780	(53)	1595	(109)	1460

BOYS	MEAN	(SD)	(% EAR)	MIN.	(% EAR)	MAX.	(% EAR)	EAR
2 yrs	1071	(179)	(84)	781	(61)	1408	(110)	1280
3 yrs	1191	(212)	(80)	879	(59)	1783	(120)	1490
4 yrs	1260	(188)	(83)	987	(65)	1727	(114)	1520

PROTEIN (g/day).

GIRLS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	32.9	(7.9)	(227)	18.6	(128)	55.0	(379)	14.5
3 yrs	34.9	(7.0)	(241)	19.9	(137)	51.4	(354)	14.5
4 yrs	38.6	(9.9)	(196)	23.6	(120)	63.6	(173)	19.7

BOYS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	33.4	(7.1)	(230)	21.7	(150)	60.3	(416)	14.5
3 yrs	38.1	(10.7)	(263)	20.0	(138)	78.7	(543)	14.5
4 yrs	39.3	(7.1)	(199)	23.1	(117)	56.3	(286)	19.7

THIAMIN (B1 mg/day).

GIRLS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	0.59	(0.13)	(118)	0.32	(64)	0.86	(172)	0.5
3 yrs	0.62	(0.15)	(124)	0.27	(54)	0.98	(196)	0.5
4 yrs	0.71	(0.18)	(101)	0.37	(53)	1.13	(161)	0.7

BOYS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	0.61	(0.15)	(122)	0.38	(76)	1.03	(206)	0.5
3 yrs	0.74	(0.19)	(148)	0.41	(82)	1.12	(224)	0.5
4 yrs	0.80	(0.18)	(114)	0.47	(67)	1.27	(181)	0.7

RIBOFLAVIN (B2 mg/day).

GIRLS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	1.15	(0.39)	(192)	0.29	(48)	2.03	(338)	0.6
3 yrs	1.15	(0.46)	(192)	0.40	(67)	2.20	(367)	0.6
4 yrs	1.22	(0.42)	(152)	0.42	(52)	1.94	(240)	0.8

BOYS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	1.18	(0.37)	(197)	0.51	(85)	1.77	(295)	0.6
3 yrs	1.25	(0.37)	(208)	0.45	(75)	2.25	(375)	0.6
4 yrs	1.41	(0.50)	(176)	0.63	(79)	3.45	(431)	0.8

TABLE 22 (continued)

NICOTINIC ACID EQUIVALENTS (mg/day).

GIRLS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	8.5	(2.6)	(107)	3.8	(47)	13.8	(172)	8
3 yrs	10.3	(3.2)	(129)	5.7	(71)	17.8	(222)	8
4 yrs	11.0	(3.0)	(100)	5.9	(54)	18.1	(164)	11
BOYS	**MEAN**	**(SD)**	**(% RNI)**	**MIN.**	**(% RNI)**	**MAX.**	**(% RNI)**	**RNI**
2 yrs	9.0	(3.4)	(112)	3.7	(41)	18.6	(232)	8
3 yrs	11.0	(3.7)	(137)	4.4	(55)	20.6	(257)	8
4 yrs	11.8	(3.6)	(107)	5.2	(47)	24.2	(220)	11

VITAMIN C (mg/day).

GIRLS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	46.0	(39.4)	(153)	7.0	(23)	171	(570)	30
3 yrs	37.6	(32.4)	(125)	6.0	(20)	146	(487)	30
4 yrs	52.9	(40.6)	(176)	10.0	(33)	163	(543)	30
BOYS	**MEAN**	**(SD)**	**(% RNI)**	**MIN.**	**(% RNI)**	**MAX.**	**(% RNI)**	**RNI**
2 yrs	33.7	(32.0)	(112)	7.0	(23)	146	(487)	30
3 yrs	43.7	(32.4)	(145)	8.0	(27)	135	(450)	30
4 yrs	43.7	(37.3)	(145)	6.0	(20)	177	(590)	30

VITAMIN A (ret. eq. mcg/day).

GIRLS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	451	(222)	(113)	108	(27)	1230	(307)	400
3 yrs	432	(233)	(108)	138	(34)	1237	(309)	400
4 yrs	484	(260)	(97)	108	(22)	1145	(229)	500
BOYS	**MEAN**	**(SD)**	**(% RNI)**	**MIN.**	**(% RNI)**	**MAX.**	**(% RNI)**	**RNI**
2 yrs	465	(397)	(116)	102	(25)	1858	(464)	400
3 yrs	510	(262)	(127)	109	(27)	1256	(314)	400
4 yrs	490	(284)	(98)	183	(37)	1558	(312)	500

VITAMIN D (ug/day).

GIRLS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	0.9	(0.4)	(13)	0.2	(3)	2.2	(31)	7
3 yrs	1.1	(0.6)	(16)	0.1	(1)	2.5	(36)	7
4 yrs	1.5	(1.3)	-	0.3	-	6.5	-	*
BOYS	**MEAN**	**(SD)**	**(% RNI)**	**MIN.**	**(% RNI)**	**MAX.**	**(% RNI)**	**RNI**
2 yrs	1.1	(0.6)	(16)	0.2	(3)	2.7	(38)	7
3 yrs	1.2	(0.7)	(17)	0.3	(4)	3.3	(47)	7
4 yrs	1.4	(0.6)	-	0.3	-	2.6	-	*

* 0 provided skin is exposed to sun.

TABLE 22 (continued)

CALCIUM (mg/day).

GIRLS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	574	(214)	(164)	187	(53)	1295	(370)	350
3 yrs	565	(212)	(161)	234	(67)	1077	(308)	350
4 yrs	609	(180)	(135)	299	(66)	1002	(223)	450

BOYS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	584	(170)	(167)	335	(96)	987	(282)	350
3 yrs	620	(241)	(177)	309	(88)	1523	(435)	350
4 yrs	649	(180)	(144)	362	(80)	1184	(263)	450

IRON (mg/day).

GIRLS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	5.1	(1.2)	(74)	2.5	(36)	7.9	(114)	6.9
3 yrs	6.0	(1.7)	(87)	3.3	(48)	11.0	(159)	6.9
4 yrs	6.5	(1.3)	(106)	3.9	(64)	8.9	(146)	6.1

BOYS	MEAN	(SD)	(% RNI)	MIN.	(% RNI)	MAX.	(% RNI)	RNI
2 yrs	5.6	(1.5)	(81)	3.1	(45)	9.3	(135)	6.9
3 yrs	6.5	(1.8)	(94)	4.1	(59)	11.9	(172)	6.9
4 yrs	7.1	(2.1)	(116)	4.2	(69)	14.2	(234)	6.1

REFERENCE: 1 Department of Health (1991).

TABLE 23

COMPARISON OF SOURCES OF ENERGY INTAKE BY AGE AND SEX.

% ENERGY FROM TOTAL FAT.

GIRLS	MEAN	(SD)	MIN	MAX	BOYS	MEAN	(SD)	MIN	MAX
2 yrs	36	(5)	23	48	2 yrs	35	(5)	23	47
3 yrs	36	(4)	23	43	3 yrs	34	(4)	27	43
4 yrs	36	(5)	24	45	4 yrs	34	(4)	25	41

% ENERGY FROM POLYUNSATURATED FAT.*

GIRLS	MEAN	(SD)	MIN	MAX	BOYS	MEAN	(SD)	MIN	MAX
2 yrs	3.5	(0.9)	1.9	6.5	2 yrs	3.8	(1.1)	1.4	6.3
3 yrs	4.3	(1.1)	2.1	7.1	3 yrs	4.3	(1.3)	2.3	7.4
4 yrs	4.2	(1.6)	2.4	10.6	4 yrs	4.1	(1.1)	2.0	6.8

% ENERGY FROM SATURATED FAT.*

GIRLS	MEAN	(SD)	MIN	MAX	BOYS	MEAN	(SD)	MIN	MAX
2 yrs	16	(3)	8	24	2 yrs	15	(3)	10	23
3 yrs	15	(3)	9	20	3 yrs	14	(3)	10	19
4 yrs	15	(3)	10	22	4 yrs	14	(3)	9	20

% ENERGY FROM STARCH AND DEXTRIN.

GIRLS	MEAN	(SD)	MIN	MAX	BOYS	MEAN	(SD)	MIN	MAX
2 yrs	19	(4)	10	28	2 yrs	21	(6)	9	34
3 yrs	21	(4)	14	31	3 yrs	23	(4)	12	30
4 yrs	21	(4)	17	33	4 yrs	23	(4)	17	33

% ENERGY FROM SUGAR.

GIRLS	MEAN	(SD)	MIN	MAX	BOYS	MEAN	(SD)	MIN	MAX
2 yrs	31	(6)	17	53	2 yrs	30	(7)	17	39
3 yrs	30	(6)	19	41	3 yrs	29	(5)	19	40
4 yrs	29	(7)	17	44	4 yrs	29	(6)	16	43

% ENERGY FROM PROTEIN.

GIRLS	MEAN	(SD)	MIN	MAX	BOYS	MEAN	(SD)	MIN	MAX
2 yrs	13	(2)	8	17	2 yrs	13	(2)	8	19
3 yrs	12	(1)	10	15	3 yrs	13	(2)	8	18
4 yrs	13	(2)	9	17	4 yrs	13	(2)	9	16

NOTE * slight underestimation as nutrient database incomplete.

TABLE 24

MAIN SOURCES OF NUTRIENTS IN CHILDREN WITH THE HIGHEST INTAKES OF FAT, FIBRE, SUGAR, AND STARCH.

SOURCES OF FAT IN TEN CHILDREN TAKING

43% - 48% OF ENERGY FROM FAT.

Main sources.	% FAT intake.
Full-fat milk	23
Margarine	11
Crisps	8
Meat products	7
Butter	4
Biscuits & cakes	4
Cheese	3
Egg dishes	3
Chips	3
Chocolate	3
Red meat	1

SOURCES OF FIBRE IN TEN CHILDREN TAKING

15g - 17g OF FIBRE PER DAY.

Main sources.	% FIBRE intake.
Wholemeal/brown bread	24
Weetabix/shreddies	10
Baked beans	9
Fresh fruit (excl. banana)	7
Banana	6
Bran flakes	4
Crisps	4
Lentil soup	4
Chips	2
White bread	2
Dried fruit	1

SOURCES OF SUGAR IN TEN CHILDREN TAKING

40% - 53% OF ENERGY FROM SUGAR.

Main sources.	% SUGAR intake.
Ribena	20
Pure fruit juice	18
Chocolate	6
Squash	5
Fresh fruit	5
Yoghurt	5
Sweets (excl. chocolate)	4
Milk	4
Coca-cola	2
Jam/honey	2
Sugar	1

SOURCES OF STARCH IN TEN CHILDREN TAKING

28% - 34% OF ENERGY FROM STARCH.

Main sources.	% STARCH intake.
White bread	20
Breakfast cereal	19
Chips	19
Crisps	5
Wholemeal bread	2
Pasta	2
Baked beans	1

Reference Nutrient Intake (RNI) - a value set at 2 SD above the EAR, thus an amount of nutrient that is enough for almost every individual, including those with high needs. The RNI is equivalent in definition to the previous RDA for nutrients, except energy (DHSS 1979).

Lower Reference Nutrient Intake (LRNI) - a value set at 2 SD below the EAR, thus an amount of nutrient that is only enough for a small number of people with low needs.

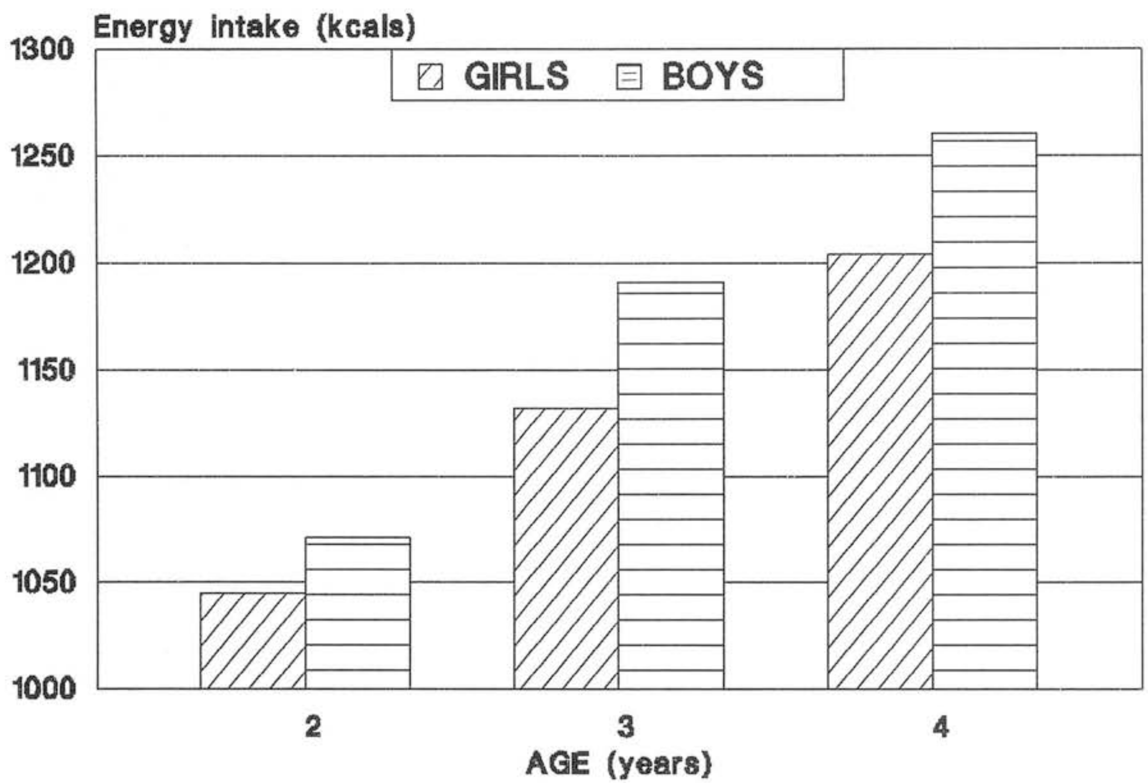
Dietary Reference Values (DRVs) - a general term used to cover the above definitions.

Energy

Across the age groups the mean energy intake of both boys and girls was similar, boys having slightly higher mean intakes than girls. There was a small increase in energy intake with age (Figure 1).

Of particular interest is a comparison of the group mean energy intakes to the Estimated Average Requirement's (EAR's) of energy (Table 22). At 2 years girls had a mean energy intake of 1045 kcal/day (85% EAR), boys 1071 kcal/day (84% EAR); at 3 years girls were taking 1132 kcal/day (83% EAR) and boys 1191 kcal/day (80% EAR); and at 4 years girls were taking 1204 kcal/day (82% EAR), boys 1260 kcal/day (83% EAR). The mean group intakes of energy were therefore 15% - 20% lower than EAR values and 20% - 25% lower than the re-

FIGURE 1
Comparison of the mean daily energy intake at 2, 3 and 4 years.



corded mean energy intake of groups of UK children studied prior to 1979. Within each group of children there was a 100% difference between the minimum and maximum figures for energy intake, and values for individuals ranged from approximately 50% to 120% of the EARs.

Figure 2 illustrates sources of energy intake (expressed as a % of energy intake) in the 7 day dietary assessments of girls (N = 110) and of boys (N = 97) .

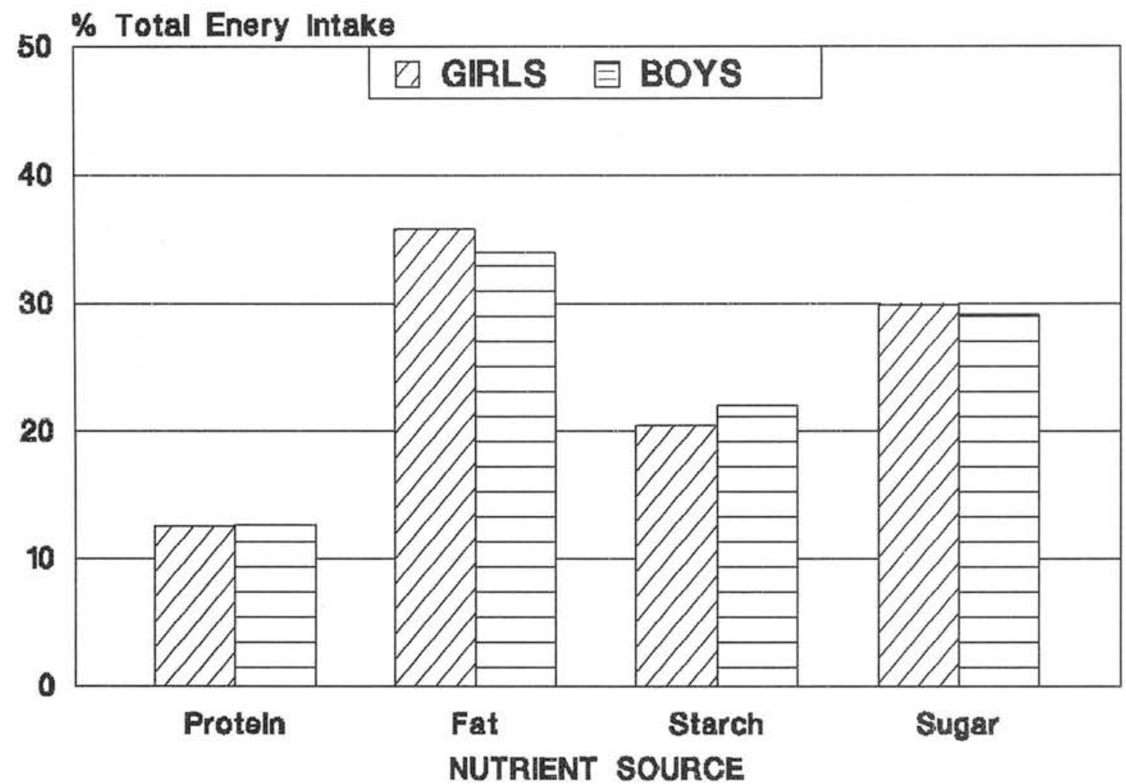
Protein

The mean protein intake (g) of each group of girls and boys was very similar, boys having a slightly higher intake than girls of the same age (Table 22). Across the age groups, for both girls and boys, there was a small statistically insignificant increase in protein intake with age.

Group mean intakes of protein were all approximately 200% of RNI values. As all group minimum values were above the RNI value for protein, it can be concluded that all children in this study were receiving an adequate intake of protein.

Expressing intake of protein as a % of energy, the mean values across all groups of children were very close, ranging from 12.3% to 12.8% of energy intake (rounded to whole figures on Table 23). This is slightly lower than the present mean average protein intake of adults of 15% of energy (Table 7) (DOH 1991).

FIGURE 2
Comparison of mean sources of energy in the diet of pre-school girls and boys



Fat

There was little difference between the mean fat intakes (g) of girls and boys respectively at 2 years (41.2g/41.7g); 3 years (44.7g/45.7g); or at 4 years (48.9g/48.1g), though within each group of children there were wide variations in intake. Expressing fat as a % of energy intake, individuals ranged from 23% to 48% energy from fat, with mean group values of 34 - 36 % energy from fat. The mean group values of boys tended to be 1% - 2% lower than girls.

Table 24 illustrates the main sources of fat in the diet of 10 children with exceptionally high fat intakes, (contributing 43% - 48% of energy from fat). Full-fat milk was a major source of fat in these children, providing 23% of total fat intake. Margarine provided 11% of fat intake, crisps 8%, meat products 7%, butter and biscuits + cakes 4% each. Chips, cheese, chocolate and eggs were relatively low contributors to total fat intake, each providing only 3%.

Fatty acids and cholesterol

Values for the intake of fatty acids (g) and as a % of energy, underestimated actual intakes, as many foods within (and added to) the database did not give figures for fatty acids (Tables 20 and 21). From the difference between % of energy from fatty acids and from total fat (with an allowance of 2.5% of energy for glycerol), it is calculated that intake of total fatty acids was underestimated by approximately 6% - 9%, (2.5% - 3% of energy intake) (DOH 1991).

The intake of polyunsaturated fats was low in both girls and boys at 3.5% and 3.8% of energy intake respectively at 2 years, rising slightly to 4.3% of energy intake at 3 - 4 years. Saturated fat intake dropped slightly from a mean of 16% energy in girls and 15% energy in boys at 2 years to 15% energy and 14% energy respectively at 3 - 4 years. These slight differences were reflected in the P:S ratio which rose from a mean of 0.23 in girls and 0.27 in boys at 2 years, to 0.3 at 3 - 4 years for both sexes.

The mean intake of cholesterol for children aged 2 - 5 years was 109 mg/day, with a range of 32 mg - 313 mg per day for individuals. There were no notable age or sex differences between the groups of children.

Sugar

The mean daily sugar intake of girls and boys respectively was: 87.7g/84.8g at 2 years; 90.4g/91.4g at 3 years; and 91.0g/98.4g at 4 years (Tables 20 and 21). The similarity of these results is emphasised by expressing sugar intake as a % of energy intake (Table 23). For girls there was a slight tendency towards lower sugar intakes from 2 years (31% energy) to 4 years (29% energy). This trend was not apparent in boys, though their sugar intake was slightly lower than that of girls at 2 and 3 years.

Within each group of children the % of energy from sugar varied from 17% to over 40%. Of ten children with high sugar intakes (contributing 40% to 53% of energy), the main sources of sugar in their diets were Ribena 20%, pure fruit juice 18% (e.g. Just Juice, Del Monte), chocolate 6%, orange squash 5%, fresh fruit 5%, fruit yoghurt 4% and sweets 4% (Table 24).

One 2 year old girl had an exceptionally high sugar intake of 53% of energy, due largely to an excessive consumption of Ribena which alone contributed 50% of her sugar intake (25% of energy intake).

Starch.

The starch intake of both boys and girls rose very slightly with age (Tables 20 and 21). The mean daily starch intake of girls and boys respectively was: 53.1g/60.4g at 2 years; 62.9g/72.2g at 3 years; and 66.7g/76.8g at 4 years. In terms of % of energy from starch (Table 23), this represents a 2% rise between 2 and 3 years of age for both girls and boys, which then appeared to stablise at mean values of 21% and 23% energy from starch respectively. Considerable variation in starch intake was found within groups, i.e. the mean intake of individual 2 year old boys ranged from 9% to 34% of energy.

Table 24 shows the main sources of starch in the diets of ten children who had high starch intakes (providing 28% to 34% of energy intake). The predominant sources of starch were white bread 20%, breakfast cereals 19% and chips 19%. Notable, though less significant sources of starch were crisps, wholemeal bread and pasta.

Dietary fibre (Non-starch polysaccharide).

The term 'fibre' refers to non-starch polysaccharide extracted by the Southgate method (Holland et. al. 1988).

The mean daily fibre intakes of girls and boys respectively were: 8.3g/9.7g at 2 years, 9.9g/11.2g at 3 years and 10.3g/11.2g at 4 years (Tables 20 and 21). Fibre intake thus increased slightly with age. Within each group of children, the mean daily intake of individuals ranged from 4g to 17g, a four-fold difference.

Sources of fibre in the diets of children taking very high fibre intakes of 15g - 17g per day (n=10) are given on table 24. Wholemeal and brown breads contributed very significantly to fibre, providing a mean intake of 24% total fibre. Wholewheat breakfast cereals (weetabix and shreddies) contributed 10% of fibre, baked beans 9%, banana alone 6% and other fruits 7%. White bread (including soft-grain white varieties) was not a major source of fibre.

Vitamins and minerals

Values for the intake of vitamins and minerals shown in tables 20, 21 and 22 are for food sources only, and do not include the contribution from dietary supplements taken by 20% - 25% of children. Table 22 summarises data for selected vitamins and minerals, with comparison to Reference Nutrient Intakes.

Only those nutrients for which previous DHSS (1979) RDA values were available have been compared to the recent RNI values of the Department of Health (1991).

Thiamin (vitamin B1).

The mean daily thiamin intake of the groups of children ranged from 100% to 148% of the RNI, suggesting that almost all individuals had an adequate intake. Although some children had intakes as low as 53% - 54% of the RNI, children with low absolute intakes of thiamin were also children with low energy intakes. When intake is expressed per 1000 kcal, children with minimal intakes were taking amounts in excess of the LRNI of 0.23 mg/1000 kcal. The main sources of thiamin were fortified breakfast cereals, milk, yoghurt, pure fruit juice, bread and potatoes.

Riboflavin (vitamin B2).

The mean group values of riboflavin intake were very high at 150% to over 200% of the RNI. However, within each group of children the mean daily intake of individuals varied greatly, particularly in girls, who had values as low as 48% - 50% of the RNI. These low intakes are similar to the LRNI values of 0.3 mg/day at 2 years and 0.4 mg/day at 4 years, suggesting that these intakes were marginally adequate. The main sources of riboflavin were fortified breakfast cereals, milk, yoghurt, cheese, pure fruit juice, bread and eggs.

Nicotinic Acid (Niacin).

Group mean values of niacin were similar to the RNI values, however the range of individual intakes varied greatly. Children with low intakes, as low as 3.7 mg/day, had intakes that do not attain the LRNI value of 4.4 mg/ 1000 kcal. The main sources of niacin were fortified breakfast cereals, bread, meat, chicken, meat products, pure fruit juice and potatoes.

Vitamin C.

Group mean values for the intake of vitamin C were high, at 112% to 176% of the RNI. However, the mean daily intake of vitamin C of individuals varied enormously from 20% to 590% of the RNI. Minimum group values of girls age 2 and 3 years and boys age 2 and 4 years were below the LRNI of 8 mg/day, thus a small number of children were at risk of vitamin C deficiency.

The main source of vitamin C was fruit juice, such as pure orange juice and Ribena. Due to an exceptionally high consumption of fruit juices by some children, the frequency distribution of vitamin C intake was positively skewed, accounting for high mean group values. Group median values for the intake of vitamin C were 36 mg, 24 mg and 41 mg for girls age 2, 3 and 4 respectively. For boys median values were 23 mg, 35 mg and 34 mg at 2, 3 and 4 years respectively. These values were above the EAR of 20 mg/day for vitamin C, but are substantially lower than group mean values.

Vitamin A (Retinol equivalents).

At 97% to 127% of the RNI for vitamin A, group mean intakes suggest that almost all individuals were receiving an adequate intake of vitamin A.

The frequency distribution of vitamin A intake was positively skewed by children who included liver or liver pate in their diet. However, group median values for the intake of vitamin A were still above the EAR value of 300 mcg/day, at 430 mcg, 424 mcg and 419 mcg for girls age 2, 3 and 4 years and 349 mcg, 441 mcg and 410 mcg for boys age 2, 3 and 4 years respectively. Group median values are therefore slightly lower than group mean values.

Despite apparently adequate mean group values, a small number of children had exceptionally low intakes of vitamin A, taking as little as 50% of the LRNI of 200 mcg/day. These were children who drank very little milk and rarely ate liver or carrots. Such children are at high risk of vitamin A deficiency. Major sources of vitamin A were liver and liver pate, full-fat milk, carrots, home-made soup, margarine and cheese.

Vitamin D

RNI values are only provided for children aged up to 3 years as it is assumed that older children will obtain adequate vitamin D from the exposure of skin to sun.

The dietary intake of vitamin D of all groups of children was low. Values ranged from 0.9 mcg/day to 1.5 mcg/day. These values are only 13% to 17% of the RNI, with individual values as low as 1%. Unless exposed to sun, or in receipt of a vitamin D supplement, young children are therefore at risk of vitamin D deficiency.

The frequency distribution for the intake of vitamin D was positively skewed by a small number of children eating fatty fish. Group median values for the intake of vitamin D were 0.9 mcg, 1.1 mcg and 1.2 mcg for girls aged 2, 3 and 4 years respectively. For boys the median values were 1.0 mcg, 1.1 mcg and 1.3 mcg at 2, 3 and 4 years respectively. Group median values are therefore very similar to group mean values.

Calcium

Group mean intakes of calcium were high at 135% to 177% of RNI values, suggesting that almost all individuals within groups were taking an adequate amount of calcium. However, 2 and 3 year old girls with the lowest intakes of calcium were barely attaining the LRNI intake of 200 mg/day.

Iron

The mean daily iron intake increased slightly with age. For younger children, especially girls, the mean iron intake was low in comparison to RNI values, i.e. girls and boys respectively were taking: 74%/81% RNI at 2 years; 87%/94% RNI at 3 years and 106%/116% RNI at 4 years.

Within each group of children, those with low intakes equivalent to the LRNI for iron were at risk of iron deficiency.

Of children who had an exceptionally high iron intake, the main source of iron was Kelloggs' bran flakes. Other iron fortified breakfast cereals, wholemeal and brown bread, liver and liver pate, meat products, baked beans, lentil soup and chocolate were also significant sources of iron.

TABLE 25

INTAKE OF ENERGY, SOURCES OF ENERGY AND FIBRE PER KG BODY WEIGHT.

GIRLS	WEIGHT (kg)	ENERGY (kcal/kg)	PROTEIN (g/kg)	FAT (g/kg)	STARCH (g/kg)	SUGAR (g/kg)	FIBRE (g/kg)	EAR[1] (kcal/kg)
2 yrs	13.5	77	2.4	3.0	3.9	6.5	0.6	95
3 yrs	15.4	74	2.3	2.9	4.0	5.9	0.6	92
4 yrs	17.6	68	2.2	2.8	3.8	5.2	0.6	87

BOYS	WEIGHT (kg)	ENERGY (kcal/kg)	PROTEIN (g/kg)	FAT (g/kg)	STARCH (g/kg)	SUGAR (g/kg)	FIBRE (g/kg)	EAR[1] (kcal/kg)
2 yrs	14.0	77	2.4	3.0	4.3	6.0	0.7	95
3 yrs	16.3	73	2.3	2.8	4.4	5.6	0.7	97
4 yrs	18.0	70	2.2	2.7	4.3	5.5	0.6	94

Reference: 1 Department of Health (1991).

Comparison of energy and nutrient intakes, per kg body weight, by age group and gender.

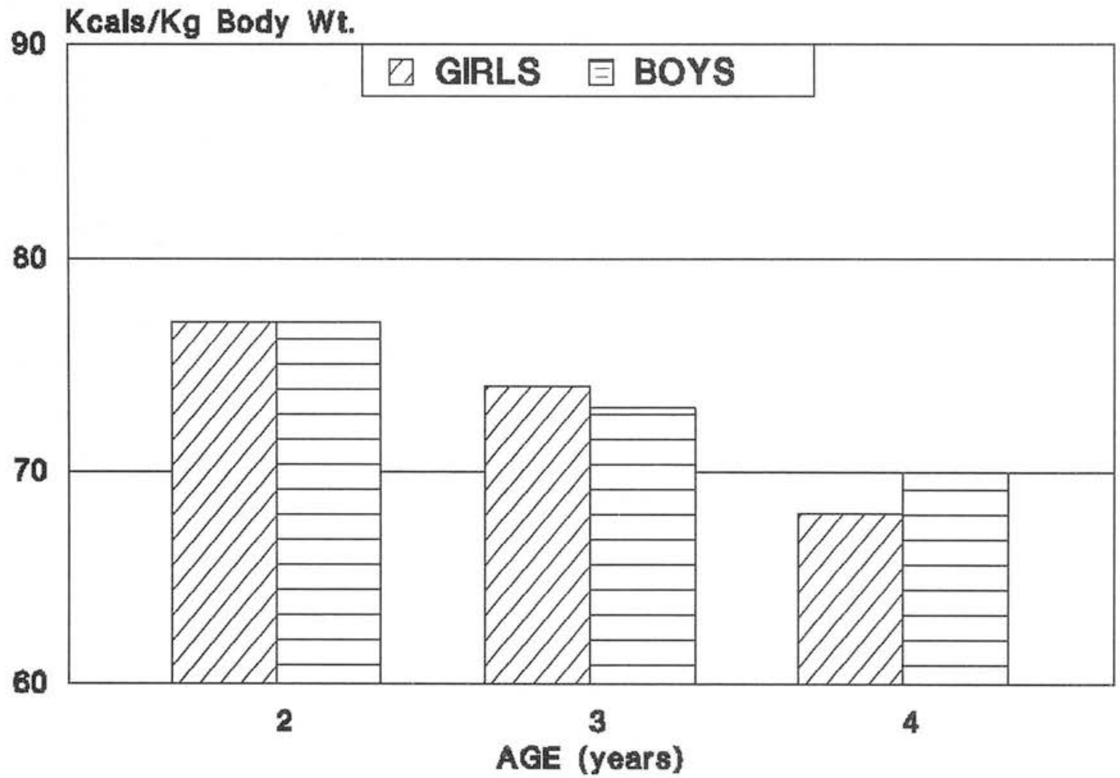
The mean intakes of energy, sources of energy and fibre per kg body weight are shown on Table 25. The EAR for energy per kg body weight is also shown (DOH 1991).

Intake of energy per kg body weight decreased slightly with age (Figure 3). For both girls and boys energy intake per kg body weight was 24% - 30% lower compared to the results of previous UK dietary surveys (Table 1). Intake of energy was also 19% - 25% lower than the Estimated Average Requirement for energy per kg body weight.

Intake of fat, sugar and protein per kg body weight decreased slightly with age. There were no notable changes in mean intake of starch or fibre per kg body weight with age. However, at 0.6g/0.7g per kg body weight, intake of fibre was relatively thrice that of adults; (i.e a 60kg woman taking 12g fibre/day = 0.2g/kg body weight, DOH 1991).

At each age there was a remarkable consistency between girls and boys for mean intakes of energy, protein, fat and fibre per kg body weight. However, intake of starch was slightly higher (0.4g/kg) for boys than girls in each age group.

FIGURE 3
Comparison of the mean energy intake /kg body weight at 2, 3 and 4 years



Comparison of average daily intake of nutrients by gender and socioeconomic group.

The mean nutrient intake of girls, grouped by their fathers' occupation, are shown in Table 26 and those of the boys in Table 27.

Socioeconomic group was correlated with nutrient intake using the Spearman Rank Correlation test, ranked on a 1 to 5 scale (I=1, II=2, IIIN=3, IIIM=4 and IV+V=5). Each nutrient was also 'ranked' prior to the correlation analysis.

Girls.

It can be seen from Table 26 that no significant trends in nutrient intake, by weight, were apparent across the socioeconomic spectrum of girls. Inspection of the actual nutrient intakes and of the correlation coefficients suggests that there was a tendency towards lower intakes of fibre and vitamin C in the 'manual'groups IIIM , IV and V and a tendency towards higher intakes of cholesterol in the non-manual groups I and II.

No significant trends across the socioeconomic groups were found in intake of total fat, fatty acids, carbohydrates and protein, expressed as a % of energy intake. There was however, a non-significant tendency towards higher total fat and saturated fatty acid intakes in group IV + V.

TABLE 26

COMPARISON OF MEAN NUTRIENT INTAKE

BY SOCIOECONOMIC GROUP OF GIRLS' FATHER

	GIRLS I	GIRLS II	GIRLS IIIN	GIRLS IIIM	GIRLS IV + V	
MEAN AGE:	37 months	38 months	39 months	36 months	44 months	
NUMBER:	N = 13	N = 24	N = 12	N = 17	N = 16	
NUTRIENT.	MEAN (SD)	MEAN (SD)	MEAN (SD)	MEAN (SD)	MEAN (SD)	R
ENERGY (kcal)	1127 (226)	1087 (184)	1111 (209)	1086 (143)	1113 (258)	-.02 NS
ENERGY (kJ)	4738 (946)	4567 (771)	4670 (878)	4560 (601)	4677 (1078)	-.02 NS
PROTEIN (g)	36.1 (6.8)	34.6 (8.2)	35.2 (11.0)	33.8 (7.2)	35.4 (10.1)	-.07 NS
FAT (g)	43.2 (7.9)	43.5 (10.0)	43.7 (10.9)	44.0 (9.3)	46.5 (15.5)	.03 NS
CHOLESTEROL (mg)	126 (53)	115 (39)	97 (45)	99 (42)	103 (65)	-.24 NS
CARBOHYDRATE (g)	157 (42)	148 (25)	154 (35)	148 (20)	147 (32)	-.08 NS
SUGAR (g)	97 (33)	85 (19)	91 (34)	88 (16)	82 (26)	-.11 NS
STARCH (g)	57.5 (13)	59 (15)	60 (16)	57 (16)	58 (15)	-.03 NS
FIBRE (g)	9.0 (1.9)	9.9 (2.9)	9.9 (3.2)	8.3 (2.2)	8.4 (1.9)	-.20 NS
CALCIUM (mg)	538 (181)	605 (231)	572 (194)	610 (184)	650 (294)	.10 NS
IRON (mg)	5.7 (1.2)	5.8 (1.4)	6.5 (1.9)	5.0 (1.0)	5.6 (1.3)	-.13 NS
VITAMIN A (ret eq mcg)	491 (205)	451 (224)	409 (212)	470 (287)	438 (224)	-.08 NS
THIAMIN (mg)	0.7 (0.2)	0.7 (0.2)	0.6 (0.2)	0.6 (0.1)	0.6 (0.2)	-.07 NS
RIBOFLAVIN (mg)	1.1 (0.3)	1.2 (0.4)	1.1 (0.3)	1.3 (0.5)	1.2 (0.5)	.05 NS
NICOT. ACID EQ. (mg)	10.7 (2.2)	9.1 (3.0)	9.8 (2.5)	8.2 (3.5)	9.1 (2.1)	-.19 NS
VITAMIN B_6 (mg)	1.0 (0.2)	0.9 (0.2)	1.0 (0.2)	0.9 (0.2)	0.9 (0.2)	-.04 NS
VITAMIN B_{12} (mcg)	2.2 (0.8)	2.4 (0.8)	2.3 (1.1)	2.6 (1.1)	2.5 (1.0)	.09 NS
VITAMIN C (mg)	55.5 (42)	49.0 (40)	48.0 (44)	33.3 (22)	41.5 (42)	-.21 NS
VITAMIN D (mcg)	1.0 (0.4)	1.0 (0.6)	1.3 (0.9)	1.1 (0.8)	1.3 (1.5)	.02 NS
VITAMIN E (mg)	2.6 (0.5)	2.8 (1.1)	2.7 (1.0)	2.6 (0.9)	2.7 (1.5)	-.09 NS
% ENERGY FROM FAT	34.8 (4.2)	35.8 (4.2)	35.5 (5.8)	36.3 (3.9)	37.1 (5.7)	.16 NS
% ENERGY FROM MUFA	11.0 (2.0)	10.8 (1.5)	11.0 (2.0)	11.2 (1.9)	11.8 (1.9)	.15 NS
% ENERGY FROM PUFA	3.7 (1.0)	3.8 (1.7)	3.9 (1.4)	4.1 (0.9)	3.7 (0.9)	.09 NS
% ENERGY FORM SFA	15.0 (2.8)	15.2 (2.8)	15.3 (3.0)	15.8 (2.6)	16.5 (3.7)	.16 NS
% ENERGY FROM TOTAL CHO	51.8 (5.2)	51.4 (4.9)	52.0 (6.8)	51.4 (5.1)	50.0 (6.8)	-.12 NS
% ENERGY STARCH/DEXTRIN	19.3 (3.4)	20.5 (5.5)	20.5 (4.1)	19.5 (4.3)	20.0 (4.2)	.02 NS
% ENERGY FROM SUGAR	31.6 (5.4)	29.6 (5.5)	30.9 (9.4)	30.8 (6.1)	27.9 (7.0)	-.11 NS
% ENERGY FROM PROTEIN	13.0 (2.1)	12.7 (2.0)	12.5 (2.2)	12.4 (1.5)	12.7 (1.5)	-.03 NS
PUFA:SAT FAT RATIO	0.25 (0.08)	0.26 (0.13)	0.26 (0.10)	0.27 (0.08)	0.23 (0.07)	-.05 NS

STATISTICAL TEST = SPEARMAN RANK CORRELATION. NS - not significant.

TABLE 27

COMPARISON OF MEAN NUTRIENT INTAKE

BY SOCIOECONOMIC GROUP OF BOYS' FATHER

	BOYS I	BOYS II	BOYS IIIN	BOYS IIIM	BOYS IV + V	
MEAN AGE:	44 months	40 months	41 months	37 months	43 months	
NUMBER:	N = 11	N = 15	N = 12	N = 21	N = 12	
NUTRIENT.	MEAN (SD)	MEAN (SD)	MEAN (SD)	MEAN (SD)	MEAN (SD)	R
ENERGY (kcal)	1173 (153)	1219 (204)	1135 (140)	1073 (164)	1226 (236)	-.11 NS
ENERGY (kJ)	4934 (644)	5129 (858)	4778 (593)	4512 (690)	5155 (989)	-.11 NS
PROTEIN (g)	37.3 (5.0)	39.0 (8.4)	36.7 (6.4)	32.7 (4.9)	42.3 (14.6)	-.13 NS
FAT (g)	43.0 (6.7)	47.3 (11.0)	42.1 (7.0)	41.5 (8.4)	49.5 (14.0)	.01 NS
CHOLESTEROL (mg)	110 (35)	136 (67)	111 (59)	96 (38)	123 (52)	-.09 NS
CARBOHYDRATE (g)	169 (27)	170 (27)	162 (36)	152 (31)	163 (30)	-.14 NS
SUGAR (g)	96 (21)	93 (22)	94 (27)	87 (22)	81 (24)	-.24 NS
STARCH (g)	70 (10)	73 (16)	65 (19)	61 (17)	77 (21)	-.07 NS
FIBRE (g)	12.4 (2.3)	11.5 (2.7)	10.6 (3.3)	8.7 (2.6)	11.8 (3.0)	-.23 NS
CALCIUM (mg)	638 (181)	617 (137)	606 (153)	596 (160)	671 (300)	-.05 NS
IRON (mg)	7.3 (2.2)	7.5 (2.7)	6.3 (1.4)	5.3 (1.3)	6.9 (1.8)	-.23 NS
VITAMIN A (ret eq mcg)	591 (384)	519 (219)	472 (291)	492 (463)	410 (290)	-.26 NS
THIAMIN (mg)	0.8 (0.2)	0.8 (0.2)	0.7 (0.2)	0.6 (0.1)	0.8 (0.2)	-.22 NS
RIBOFLAVIN (mg)	1.5 (0.8)	1.4 (0.3)	1.2 (0.3)	1.2 (0.3)	1.3 (0.4)	-.14 NS
NICOTINIC ACID EQ. (mg)	10.8 (2.2)	11.4 (3.9)	11.3 (4.5)	8.6 (2.5)	12.1 (4.9)	-.14 NS
VITAMIN B_6 (mg)	1.0 (0.2)	1.1 (0.3)	1.1 (0.5)	0.9 (0.2)	1.2 (0.3)	-.04 NS
VITAMIN B_{12} (mcg)	1.5 (0.8)	2.5 (1.0)	3.0 (1.7)	2.8 (1.9)	2.8 (0.9)	.06 NS
VITAMIN C (mg)	43.9 (34)	58.2 (43)	45.4 (45)	26.0 (15)	33.5 (17)	-.20 NS
VITAMIN D (mcg)	1.2 (0.6)	1.7 (0.8)	1.4 (0.7)	1.1 (0.6)	1.1 (0.6)	-.19 NS
VITAMIN E (mg)	3.0 (0.5)	3.0 (0.7)	2.6 (0.8)	2.4 (0.6)	3.2 (1.8)	-.22 NS
% ENERGY FROM FAT	33.1 (2.8)	34.7 (3.5)	33.7 (6.3)	34.9 (5.1)	36.2 (5.2)	.17 NS
% ENERGY FROM MUFA	9.8 (1.4)	10.0 (1.8)	10.5 (2.3)	10.5 (1.8)	11.9 (1.9)	.31 *
% ENERGY FROM PUFA	4.2 (1.2)	4.4 (1.4)	3.8 (1.2)	3.7 (1.0)	3.9 (1.0)	-.17 NS
% ENERGY FORM SFA	13.9 (2.3)	13.9 (2.5)	14.6 (3.6)	15.4 (3.5)	15.1 (2.3)	.21 NS
% ENERGY FROM TOTAL CHO	53.9 (3.9)	52.5 (4.6)	53.2 (7.7)	52.9 (5.5)	50.2 (6.2)	-.15 NS
% ENERGY STARCH/DEXTRIN	22.5 (2.6)	22.7 (4.5)	21.3 (4.9)	21.4 (5.5)	23.5 (4.8)	-.02 NS
% ENERGY FROM SUGAR	30.5 (4.2)	28.6 (5.7)	30.6 (6.8)	30.3 (5.4)	25.0 (7.1)	-.16 NS
% ENERGY FROM PROTEIN	12.8 (1.4)	12.8 (1.6)	12.9 (1.9)	12.3 (1.9)	13.7 (2.9)	.04 NS
PUFA:SAT FAT RATIO	0.32 (0.13)	0.34 (0.13)	0.27 (0.12)	0.26 (0.10)	0.27 (0.07)	-.21 NS

STATISTICAL TEST = SPEARMAN RANK CORRELATION. * $P < 0.01$ 1-tailed significance NS - not significant.

The mean age of girls of group IV + V, at 44 months, was slightly older by 5 - 8 months than that of the girls of other groups. This could be said to be a source of bias, resulting in, for instance, a higher energy intake. However, the energy intake of group IV + V was not notably higher than that of the other groups and only 19 kcal lower than 3 year old girls (Table 20) with a mean age of 42 months. This suggests that an age difference of 5 - 8 months between mean group ages is not an appreciable source of bias in the comparison of nutrient intake by socioeconomic group.

Boys

It can be seen for boys (Table 27), that no significant trends in nutrient intakes, by weight, were apparent across the socioeconomic spectrum. There was however, a tendency towards lower intakes of sugar and vitamin C in the 'manual'groups IIIM , IV and V and a tendency towards higher intakes of Iron and Vitamin A in the non-manual groups I and II.

No significant trends were apparent across the socioeconomic groups for intake of total fat, carbohydrates and protein, expressed as a % of energy intake. Interestingly, there was a significant association with type of fatty acid and social group, with the manual groups taking significantly more monounsaturated fatty acids, and also a tendency (not significant) towards higher intakes of saturated fat and lower intakes of polyunsaturated fat.

Comparison of the quality of the diet of pre-school children with older children and adults, by examination of mean nutrient intakes per 1000 kcal.

This method of analysis (Tables 28 and 29) permits valid comparison of the nutrient intake of very different age groups of people, as values are not biased by variation in total daily energy intake.

Protein

The intake of protein of both girls and boys is throughout childhood at a mean level of 30g/1000 kcal, rising during adulthood to 37g/1000 kcal in women and 34g /1000 kcal in men.

Fat

Fat intake is lowest in the pre-school age group, at 40g/1000 kcal (36% energy) in girls and 38.5g/1000 kcal (34.5% energy) in boys. This rises to a mean level of 43g/1000 kcal in both male and female school-children, remaining fairly constant into adulthood, providing 38%-39% of total calories (40% of energy from both men and women if alcohol energy is excluded).

TABLE 28

COMPARISON OF MEAN NUTRIENT INTAKE PER 1000 KCAL

BETWEEN PRE-SCHOOL GIRLS, OLDER GIRLS AND WOMEN

NUTRIENT.	PRESENT STUDY GIRLS 2 - 5 YEARS	SCOTTISH GIRLS 10/11 YRS.[1]	SCOTTISH GIRLS 14/15 YRS.[1]	WOMEN 16-64 YRS.[2]	NUTRIENT.
ENERGY (kcal)	1000	1000	1000	1000	ENERGY (kcal)
PROTEIN (g)	31.5	30	28	37	PROTEIN (g)
FAT (g)	40	43	43.5	44	FAT (g)
CARBOHYDRATE (g)	137	130	131	115	CHO (g)
SUGAR (g)	80	N/A	N/A	50.5 (48 SCOT)	SUGAR (g)
STARCH (g)	54	N/A	N/A	63 (65 SCOT)	STARCH (g)
FIBRE (g)	8.5	N/A	N/A	11.2 (10.7 ")	FIBRE (g)
CALCIUM (mg)	519	407	366	437	CALCIUM (mg)
IRON (mg)	5.2	4.7	4.5	6.4	IRON (mg)
COPPER (mg)	0.5	N/A	N/A	0.7	COPPER (mg)
ZINC (mg)	3.7	N/A	N/A	5.1	ZINC (mg)
CAROTENE (mcg)	997	505	467	1212 (SCOTLAND)	CAROTENE (mcg)
RETINOL (mcg)	241	236	183	624 "	RETINOL (mcg)
VITAMIN A (ret. eq. mcg)	407	324	259	826 "	VITAMIN A (ret. eq. mcg)
THIAMIN (mg)	0.6	0.5	0.5	0.7 "	THIAMIN (mg)
RIBOFLAVIN (mg)	1.0	0.7	0.6	0.9 "	RIBOFLAVIN (mg)
NICOTINIC ACID EQ. (mg)	9	12	11	18 "	NICOTINIC ACID EQ. (mg)
VITAMIN B_6 (mg)	0.9	0.5	0.5	1.0 "	VITAMIN B_6 (mg)
VITAMIN B_{12} (mcg)	2.2	N/A	N/A	3.2 "	VITAMIN B_{12} (mcg)
BIOTIN (mcg)	9.9	N/A	N/A	21 "	BIOTIN (mcg)
VITAMIN C (mg)	40	22	22	39 "	VITAMIN C (mg)
VITAMIN D (mcg)	1.0	0.6	0.6	1.6 "	VITAMIN D (mcg)
VITAMIN E (mg)	2.6	N/A	N/A	4.3 "	VITAMIN E (mg)
% ENERGY FROM FAT	36	39	39	39 (40 ex. alcohol)	
% ENERGY FROM SUGAR	30	N/A	N/A	19 (18 SCOTLAND)	
% ENERGY FROM STARCH	20	N/A	N/A	23.5 (24.5 SCOT)	
% ENERGY FROM TOTAL CHO	51.5	49	49.5	43	
% ENERGY FROM PROTEIN	12.5	12	11.5	15	

FOOTNOTE: For women, Scottish data is given where available, otherwise mean UK data is provided.

REFERENCES: 1. DOH (1989b) 2. OPCS (1990). N/A = not available.

TABLE 29

COMPARISON OF MEAN NUTRIENT INTAKE PER 1000 KCAL

BETWEEN PRE-SCHOOL BOYS, OLDER BOYS AND MEN

NUTRIENT	PRESENT STUDY BOYS 2 - 5 YRS.	SCOTTISH BOYS 10/11 YRS.[1]	SCOTTISH BOYS 14/15 YRS.[1]	MEN 16 - 64 YRS.[2]		NUTRIENT.
ENERGY (kcal)	1000	1000	1000	1000		ENERGY (kcal)
PROTEIN (g)	31.5	30.5	30	34.5		PROTEIN (g)
FAT (g)	38.5	42.5	43	42		FAT (g)
CARBOHYDRATE (g)	141	131	130	111		CHO (g)
SUGAR (g)	78	N/A	N/A	46	(42 SCOT)	SUGAR (g)
STARCH (g)	59	N/A	N/A	64	(65.5 SCOT)	STARCH (g)
FIBRE (g)	9	N/A	N/A	10.3	(9.7 ")	FIBRE (g)
CALCIUM (mg)	527	430	388	386		CALCIUM (mg)
IRON (mg)	5.5	4.8	4.8	5.7		IRON (mg)
COPPER (mg)	0.5	N/A	N/A	0.7		COPPER (mg)
ZINC (mg)	3.9	N/A	N/A	4.7		ZINC (mg)
CAROTENE (mcg)	849	489	452	962	(SCOTLAND)	CAROTENE (mcg)
RETINOL (mcg)	276	220	291	405	"	RETINOL (mcg)
VITAMIN A (ret. eq. mcg)	417	303	363	565	"	VITAMIN A (ret. eq. mcg)
THIAMIN (mg)	0.6	0.6	0.6	0.7	"	THIAMIN (mg)
RIBOFLAVIN (mg)	1.1	0.8	0.8	0.9	"	RIBOFLAVIN (mg)
NICOTINIC ACID EQ. (mg)	9	13	13	17	"	NICOTINIC ACID EQ. (mg)
VITAMIN B_6(mg)	0.9	0.6	0.5	1.1	"	VITAMIN B_6 (mg)
VITAMIN B_{12} (mcg)	2.2	N/A	N/A	2.9	"	VITAMIN B_{12} (mcg)
BIOTIN (mcg)	10.5	N/A	N/A	16	"	BIOTIN (mcg)
VITAMIN C (mg)	34	21	18	27	"	VITAMIN C (mg)
VITAMIN D (mcg)	1.1	0.6	0.7	1.4	"	VITAMIN D (mcg)
VITAMIN E (mg)	2.4	N/A	N/A	3.9	"	VITAMIN E (mg)
% ENERGY FROM FAT	34.5	38	39	38	(40 ex. alcohol)	
% ENERGY FROM SUGAR	29	N/A	N/A	17	(16 SCOTLAND)	
% ENERGY FROM STARCH	22	N/A	N/A	24	(25 SCOTLAND)	
% ENERGY FROM TOTAL CHO	53	49	49	42		
% ENERGY FROM PROTEIN	12.5	12	12	14		

FOOTNOTE: For men, Scottish data is given where available, otherwise mean UK data is provided.

REFERENCES: 1. DOH (1989b) 2. OPCS (1990) N/A = not available.

Carbohydrate

The total carbohydrate intake of pre-school girls and boys is higher than either school-children or adults, at 137g/1000 kcal (51.5% energy) and 141g/1000 kcal (53% energy) respectively. Older children have an intake of 130g/131g per 1000 kcal (49% energy), whilst in adulthood women have a mean intake of 115g/1000 kcal (43% energy) and men a mean intake of 111g/1000 kcal (42% energy). Of particular interest is the changing pattern of intake of sugar and starch.

Sugar intake is high in girls and boys at 2 - 5 years, at 80g/1000 kcal (30% energy) and 78g/1000 kcal (29% energy) respectively, dropping by 40% - 46% during childhood to an intake of 48g/1000 kcal (18% energy) in Scottish women and 42g/1000 kcal (16% energy) in Scottish men.

In contrast starch intake rises during childhood from a mean intake of 54g/1000 kcal (20% energy) in pre-school girls and 59g/1000 kcal (22% energy) in pre-school boys, to a mean intake of 65g/1000 kcal in Scottish men and women (25% energy).

No information is available on the sugar or starch intake of the 10 to 15 year old children studied by the Department of Health (1989). Nelson (1991) and McNeill et al. (1991) found the mean sugar intake 11 - 12 year old schoolchildren to be 21 - 22% of energy. McNeill (1991) found a starch intake of 27 - 29% of energy in 61 Scottish 12 year old children.

The sugar and fibre intake of Scottish adults is slightly lower than that of the general UK population, whilst intake of starch is slightly higher.

In pre-school girls and boys, fibre intake is 8.5g and 9g/1000 kcal. This rises during childhood to a mean intake of 10.7g and 9.7g/1000 kcal respectively in Scottish women and men.

Minerals and vitamins.

A comparison of the mean mineral and vitamin intake per 1000 kcal of pre-school children with older children and adults reveals the diet of 14/15 year old children to be the least nutrient dense. In both girls and boys, mean intake of iron and vitamins A, D, B1, B2, B6 and C per 1000 kcal is higher in pre-school children than in school-children, levels being particularly low in 14/15 year old children, though rising again in adulthood.

INVESTIGATION OF THE INFLUENCE OF DIETARY COMPOSITION ON NUTRIENT INTAKE AND OF THE RELATIONSHIP BETWEEN NUTRIENTS

Selection of vitamins and mineral has been necessary in most of the following tables for clarity of presentation. Therefore, if a nutrient deficiency is particularly rare in UK children, it has not been included in every table. Such nutrients include copper, biotin, folic acid and pantothenic acid.

Correlation of total daily energy intake with intake of fat, protein and carbohydrate, expressed as a % of energy intake.

This method of analysis investigates the influence of variation in dietary composition on energy intake (Table 30). No evidence was found to suggest that the composition of the diet of young children taking a Western diet (23 - 48% energy from fat; 17 - 50% energy from sugar; 10 - 33% energy from starch) influenced total energy intake.

It therefore appears that young children were able to adapt to variation in dietary composition to maintain energy intake. Thus, for instance, children who drank a great deal of sugary juice obtained a large proportion of their energy from sugar but did not increase their total energy intake. Similarly, children who ate energy dense fatty foods did not consume more energy, in total, than those eating a low fat diet.

TABLE 30

CORRELATION OF TOTAL DAILY ENERGY INTAKE WITH INTAKE OF FAT, PROTEIN AND CARBOHYDRATE, EXPRESSED AS A % OF ENERGY INTAKE, (N = 207).

% of energy from:	r	significance.
FAT	.08	NS
MUFA	.01	NS
PUFA	.04	NS
SFA	.02	NS
PROTEIN	.00	NS
TOTAL CHO	-.07	NS
STARCH & DEXTRIN	-.07	NS
SUGAR	-.01	NS

PEARSON CORRELATION TEST: NS - not significant.

TABLE 31

CORRELATION OF TOTAL DAILY ENERGY INTAKE WITH AVERAGE DAILY INTAKE OF INDIVIDUAL NUTRIENTS (N = 207).

Nutrient:	r	Significance.
FAT (g/day)	.82	**
SFA (g/day)	.69	**
PUFA (g/day)	.52	**
CHOLESTEROL (mg/day)	.47	**
P:S RATIO	.04	NS
TOTAL CHO (g/day)	.84	**
SUGAR (g/day)	.61	**
STARCH & DEXTRIN (g/day)	.63	**
PROTEIN (g/day)	.78	**
FIBRE (g/day)	.49	**
CALCIUM (mg/day)	.54	**
IRON (mg/day)	.69	**
ZINC (mg/day)	.68	**
(L) VITAMIN A (ret eq/d)	.31	**
(L) VITAMIN D (mcg/day)	.36	**
(L) VITAMIN E (mg/day)	.47	**
VITAMIN B1 (mg/day)	.53	**
VITAMIN B2 (mg/day)	.33	**
NICOTINIC ACID EQ. (mg/day)	.44	**
TRYPTOPHAN (mg/day)	.21	*
VITAMIN B6 (mg/day)	.47	**
VITAMIN B12 (mcg/day)	.33	**
(L) VITAMIN C (mg/day)	.32	**

PEARSON CORRELATION TEST: * $P < 0.01$ ** $P < 0.001$
1-tailed significance.

(L) logarithmic transformation

Correlation of total daily energy intake with avarage daily intake of individual nutrients.

Irrespective of the balance between protein, fat and carbohydrate in the diet of pre-school children, the relationship between energy intake and intake of macronutrients was very strong, i.e. the correlation coefficients between energy intake and intake of protein, fat and total carbohydrate were 0.78, 0.82 and 0.84 respectively ($P<0.001$) (Table 31). Thus variation in total energy intake accounted for much of the variation in absolute intake of macronutrients.

Variation in the intake of other nutrients was also associated with total energy intake, the association being strongest for nutrients found in a wide variety of foods. Thus energy intake was highly correlated with intake of fibre (0.49), iron (0.69) and zinc (0.68), whilst intakes of vitamin A (0.31) and vitamin C (0.32) was significantly though less strongly associated with energy intake ($P<0.001$).

The frequency distributions for the intake of fat soluble vitamins A, D and E, and of vitamin C were positively skewed by a minority of children with exceptionally high intakes. It was therefore necessary to log transform the distributions (base 10) to obtain normalised frequency distributions prior to applying the Pearson correlation statistical test.

Correlation of the intake of fat, protein and carbohydrate, expressed as a % of energy intake, with each other.

Expressing macronutrient intake as a % of energy intake permits comparisons that are unbiased by variation in energy intake (Table 32).

A strong inverse relationship of -0.94 was found to exist between intake of total fat and total carbohydrate ($P<0.001$). The strength of relationship between total fat and sugar intake was twice as strong as that between total fat and starch intake, with correlation coefficients of -0.63 and -0.32 respectively ($P<0.001$). Thus variations in total fat intake tend to have a greater effect on intake of sugar, for maintenance of energy intake, than on intake of starch.

There was a strong correlation of 0.83 between intake of total fat and saturated fat (SFA). The effect of variation in SFA on intake of sugar and starch was very similar to the pattern of variation with total fat. However, the effect of variation in polyunsaturated fat (PUFA) on the carbohydrate component of the diet did not follow the same pattern. There was a significant but weak association for intake of PUFA with total fat of 0.18 ($P<0.01$) and a negative association of -0.25 for PUFA with intake of sugar ($P<0.001$). In contrast to the negative relationships between intake of total fat and starch of -0.32 and SFA and starch of -0.46 ($P<0.001$), a posi-

TABLE 32

CORRELATION OF THE INTAKE OF FAT, PROTEIN AND CARBOHYDRATES, EXPRESSED AS A % OF ENERGY INTAKE, WITH EACH OTHER (N = 207)

% OF ENERGY FROM:	FAT	PUFA	SFA	TOTAL CHO	SUGAR	STARCH	PROTEIN
FAT	1.0						
PUFA	.18*	1.0					
SFA	.83**	-.15	1.0				
TOTAL CHO	-.94**	-.11	-.81**	1.0			
SUGAR	-.63**	-.25**	-.38**	.68**	1.0		
STARCH	-.32**	.20*	-.46**	.31**	-.46**	1.0	
PROTEIN	.20*	-.12	.26**	-.51**	-.45**	-.02	1.0

PEARSON CORRELATION TEST: * P < 0.01 ** P < 0.001 1-tailed significance tive relationship was found to exist between PUFA and starch of 0.20 (P<0.01). This was partly because PUFA is a much smaller component of total fat intake than SFA (Tables 20 and 21), thus variations are less influential on carbohydrate intake, and partly because the use of polyunsaturated margarine is associated with a dietary pattern characterised by lower intakes of full-fat milk and more frequent use of bread, cereals and fruit juice.

The significant negative relationship between protein intake and total carbohydrate intake is of interest as it was entirely related to the sugar component of the diet. No relationship was found between protein intake and starch intake. As the most important source of protein in a child's diet is milk there was a positive relationship between protein intake and fat intake of 0.20 (P<0.01). There was also a strong negative relationship between protein intake and sugar intake of -0.45 (P<0.001), as children who drank little milk tended to drink large amounts of sugary juices such as pure fruit juice and Ribena.

Correlation of the intake of fat, protein and carbohydrate, expressed as a % of energy intake, with the intake of nutrients by weight per 1000 kcal.

This method of analysis permits a valid investigation of the relationship between intake of nutrients (Table 33), without bias due to variation in energy intake.

TABLE 33

CORRELATION OF THE INTAKE OF FAT, PROTEIN AND CARBOHYDRATE, EXPRESSED AS % OF ENERGY INTAKE, WITH THE INTAKE OF SPECIFIC NUTRIENTS BY WEIGHT PER 1000 Kcal (N = 207).

	% OF ENERGY FROM:					
NUTRIENT (wt/1000 kcal)	FAT	PUFA	SFA	STARCH	SUGAR	PROTEIN
FIBRE	-.32 **	.26 **	-.44 **	.50 **	-.13	.08
CALCIUM	.37 **	-.22 **	.56 **	-.39 **	-.14	.56 **
IRON	-.35 **	.11	-.43 **	.43 **	-.09	.13
ZINC	.07	.00	.10	-.04	-.25 **	.68 **
VITAMIN B1	-.27 **	.05	-.24 **	.38 **	-.16 *	.33 **
VITAMIN B2	-.06	-.12	.10	-.13	.07	.33 **
NICOTINIC ACID EQ.	-.33 **	.03	-.35 **	.53 **	-.23 **	.24 **
VITAMIN B12	.22 **	-.20 *	.37 **	-.13	-.20 *	.44 **
VITAMIN B6	-.20 *	-.05	-.15	.36 **	-.19 *	.23 **
VITAMIN C (L)	-.34 **	.06	-.31 **	-.13	.38 **	-.08
VITAMIN A (L)	.26 **	.00	.28 **	-.23 **	-.13	.35 **
VITAMIN D (L)	.04	.38 **	-.13	.13	-.17 *	.05
VITAMIN E (L)	.18 *	.52 **	-.03	-.01	-.09	-.19 *

PEARSON CORRELATION TEST: * P < 0.01 ** P < 0.001 1-tailed significance.

(L) Logarithmic transformation.

There were significant negative associations between intake of total fat and SFA, respectively, with intake of dietary fibre (-0.32/-0.44), iron (-0.35/-0.43), vitamin B1 (-0.27/-0.24), nicotinic acid (-0.33/-0.35) and vitamin C (-0.34/-0.31) ($P<0.001$). Intake of vitamin A and vitamin E however, being fat soluble vitamins, were positively associated with total fat intake.

Polyunsaturated fat was positively correlated with intake of fibre, $r = 0.26$ ($P<0.001$). Thus children with a high intake of fibre were more likely to use a polyunsaturated spread but tended to have a low total fat intake.

Sugar and starch, components of carbohydrate, had a tendency to opposing relationships with the intake of fibre, vitamins and minerals.

There were strong positive associations between intake of starch with fibre (0.50), iron (0.43), vitamin B1 (0.38), nicotinic acid (0.53) and vitamin B6 (0.36) ($P<0.001$). This was partly because cereals are naturally a good source of the latter nutrients, and partly because breakfast cereals, which form a significant component of childrens' starch intake, tend to be fortified with minerals and vitamins. Starch was negatively associated with intake of calcium (-0.39) and vitamin A (-0.23) as children who drank little milk were maintaining their energy intake with a higher carbohydrate intake ($P<0.001$).

A high sugar intake tends to reduce intake of minerals and vitamins, thus sugar intake was negatively associated with intake of zinc (-0.25) and nicotinic acid (-0.23) (P<0.001), and also vitamin B1 (-0.16), vitamin B12 (-0.20), vitamin B6 (-0.19) and vitamin D (-0.17) (P<0.01). An exception was the strong positive relationship between sugar intake and vitamin C of 0.38 (P<0.001), arising because children obtained a large proportion of their sugar from Ribena and pure fruit juice, rich sources of vitamin C.

As the most significant source of protein in the diet of young children is milk and milk products there were highly significant positive correlations for protein with intake of calcium (0.56), vitamin B1 (0.33), vitamin B2 (0.33) and vitamin A (0.35) (P<0.001). Protein intake was also positively correlated with intake of zinc (0.68), nicotinic acid (0.24), vitamin B12 (0.44), and vitamin B6 (0.23) as meat and meat products were rich sources of these nutrients (P<0.001).

Correlation of specific nutrient intakes per 1000 kcal with each other.

Table 34 demonstrates strong relationships between the intake of minerals and vitamins. Fibre intake was negatively associated with calcium intake (-0.24) partly because foods rich in fibre, such as wholemeal bread and cereals, are poor sources of calcium and partly because

TABLE 34

CORRELATION OF SPECIFIC NUTRIENT INTAKES PER 1000 kcal WITH EACH OTHER (N = 207).

	FIBRE	CALCIUM	IRON	ZINC	VIT. B1	VIT. B2	NICOTINIC ACID	VIT. B6	VIT. B12	VIT. A	VIT. D	VIT. C
FIBRE	1.0											
CALCIUM	-.24 **	1.0										
IRON	.61 **	-.28 **	1.0									
ZINC	.26 **	.41 **	.28 **	1.0								
VIT. B1	.41 **	.11	.62 **	.51 **	1.0							
VIT. B2	-.04	.55 **	.20 *	.39 **	.51 **	1.0						
NIC. ACID	.34 **	-.44 **	.52 **	.20 **	.47 **	-.03	1.0					
VIT. B6	.25 **	-.06	.46 **	.22 **	.53 **	.26 **	.68 **	1.0				
VIT. B12	-.29 **	.45 **	-.04	.26 **	.12	.37 **	.10	.32 **	1.0			
VIT. A(L)	-.09	.39 **	.07	.32 **	.17 *	.31 **	-.17 *	-.01	.55 **	1.0		
VIT. D(L)	.01	-.09	.32 **	.08	.31 **	.09	.19 *	.24 **	.17 *	.22	1.0	
VIT. C(L)	.19*	-.12	.24 **	.14	.25 **	.00	.11	.24 **	-.07	.14	.11	1.0

PEARSON CORRELATION TEST: * P < 0.01 ** P < 0.001 1-tailed significance.

(L) Logarithmic transformation.

children who drank a great deal of milk received less energy from high fibre starchy foods (Table 48). Fibre intake was also negatively correlated with vitamin B12 (-0.29) as fibre is only derived from vegetable sources and vitamin B12 from animal sources ($P<0.001$). Intake of fibre was positively associated with intake of iron (0.61), zinc (0.26) and vitamin B1 (0.41) as bread and fortified breakfast cereals are major sources of both fibre and these nutrients ($P<0.001$).

Calcium intake was strongly related to the intake of vitamin B2 (0.55), vitamin B12 (0.45) and vitamin A (0.39) as milk is a major source of all four nutrients ($P<0.001$).

A strong positive relationship between intake of iron, zinc and B group vitamins was generally related to the consumption of bread, breakfast cereals and pure fruit juices as they are major sources of these nutrients.

The conclusion to be drawn from the strong positive relationships between intake of nutrients found in Table 34, is that children who had a low intake of one nutrient were likely to have a low intake of a range of associated nutrients.

Correlation of the average daily intake of specific nutrients during the first 7 day survey with the corresponding nutrient intake during the second survey.

For each nutrient there was a highly significant correlation of intake during the first survey with the second survey, thus a degree of "tracking" of nutrient intake was found (Table 35). The association was strongest for intake, by weight, of starch (0.77), protein (0.68), sugar (0.62) and cholesterol (0.64). However, the correlation coefficients for intake of starch and protein as % of energy were lower, at 0.69 and 0.48 respectively, suggesting that older children met their increased energy requirements by a proportionally greater intake, by weight, of fat and sugar than of starch and protein. As the correlation coefficients for intake of total fat and % energy from fat were only 0.50 and 0.54 respectively, a slightly greater degree of variation in fat intake with age is suggested.

The correlation coefficient for intake of energy was high at 0.57. This is a strong relationship bearing in mind that the energy requirements of children, thus energy intake, are affected by variations in physical activity and, to a lesser extent, rate of growth.

The correlation coefficients for intake of fibre and most vitamins were above 0.5, suggesting a close relationship between the two surveys. Thus low intakes of fibre and vitamins had a tendency to persist with age.

TABLE 35

CORRELATION OF THE AVERAGE DAILY INTAKE OF SPECIFIC NUTRIENTS DURING THE INITIAL 7 DAY SURVEY WITH THE CORRESPONDING NUTRIENT INTAKE DURING THE REPEAT 7 DAY SURVEY (N = 54).

NUTRIENT	r	NUTRIENT	r
Average daily ENERGY intake	.57 **	Average daily intake of:	
% energy from FAT	.54 **	FAT (g)	.50 **
% energy from MUFA	.50 **	MUFA (g)	.48 **
% energy from PUFA	.50 **	PUFA (g)	.58 **
% energy from SFA	.44 **	SFA (g)	.46 **
% energy from TOTAL CHO	.62 **	TOTAL CHO (g)	.58 **
% energy from STARCH	.69 **	STARCH (g)	.77 **
% energy from SUGAR	.62 **	SUGAR (g)	.62 **
% energy from PROTEIN	.43 **	PROTEIN (g)	.68 **
P:S ratio	.58 **	FIBRE (g)	.54 **
Average daily intake of:		CHOLESTEROL (mg)	.64 **
CALCIUM (mg)	.58 **	VITAMIN B1 (mg)	.53 **
MAGNESIUM (mg)	.54 **	VITAMIN B2 (mg)	.60 **
IRON (mg)	.62 **	NICOTINIC ACID EQ. (mg)	.46 **
(L) VITAMIN C (mg)	.54 **	VITAMIN B6 (mg)	.48 **
(L) VITAMIN A (ret eq. mcg)	.32 *	VITAMIN B12 (mcg)	.63 **
(L) VITAMIN D (mcg)	.52 **	TOTAL FOLIC ACID (mcg)	.56 **
(L) VITAMIN E (mg)	.47 **	PANTOTHENIC ACID (mg)	.60 **
		BIOTIN (mcg)	.64 **

PEARSON CORRELATION TEST: * P < 0.01 ** P < 0.001 1-tailed significance.

(L) Logarithmic transformation

COMPARISON OF GROWTH PARAMETERS TO STANDARDS OF GROWTH.

Summary of anthropometric measurements, with comparison to accepted standards of growth.

The anthropometric results for girls aged 2 years, 3 years and 4 years are shown in Table 36, and for boys in Table 37. Mean values for each parameter measured, the standard deviation, minimum and maximum are given and similarly, group percentile values for height, weight and skinfold measurements are shown.

Table 38 provides a summary of mean values alone for each group of girls and boys, for rapid comparison.

Weight

Mean group values of weight were on the 50th centile for girls and marginally higher for boys. Within each group of girls and boys weights were distributed across the normal range. No child fell below the third percentile, though some tall children were on or above the 97th percentile for weight. Some children had a high 'weight for height' but none was obese.

Height

For both girls and boys the mean group values for height were well above the 50th percentile, ranging from a mean percentile value of 57 for 2 year old girls to 67 for the group of 2 year old boys. Within each group of children heights were distributed across the normal range for age. No child was below the 7th percentile for height, a few tall children fell above the normal range for age. One 2 year old boy (30 months) was the average height of a child of five years.

Mid-arm and mid-calf circumferences

At each age the mean group values and range of measurements for both mid-arm and mid-calf circumferences were very similar for both girls and boys. There was a slight tendency, more pronounced in girls, for measurements to increase with age. No UK standards are available for either measurement for children of this age.

Triceps skinfold thickness

For each group of children the measurements of triceps skinfold thickness were distributed across the standard range for age but tended to be negatively skewed (except for 3 year old boys) with mean values well below the 50th percentile. The range of measurements, and mean group values of girls at 9.6mm - 9.9mm (34 - 39 percent) were very similar. There was a greater variation in measurement among boys, with the group mean value of 2 year olds being low at 9.0mm (31 percent), and the group mean value of 3 year olds being relatively high at 10.2mm (55 percent).

TABLE 36

SUMMARY OF GIRLS ANTHROPOMETRIC MEASUREMENTS, WITH COMPARISON TO ACCEPTED STANDARDS[1,2,3].

GIRLS AGE 2 YEARS (N = 41).

Variable	Mean	Std Dev	Minimum	Maximum
AGE (months)	30.7	2.9	26	35
WEIGHT (kg)	13.4	1.4	10.9	16.9
WT. PERCENTILE[1]	55	25	3	97
WT./HT. PERCENTILE[2]	60	22	10	90
HEIGHT (cm)	90.3	3.9	81.5	99.6
HT.PERCENTILE[1]	57	25	10	97
MID-ARM CIRC. (cm)	16.6	1.0	14.0	18.5
MID-CALF CIRC.(cm)	21.1	1.3	17.7	23.9
TRICEPS S'FOLD (mm)	9.8	1.9	6.4	16.0
TRICEPS S'FOLD PERCENTILE.[3]	34	22	3	93
SUB-SCAP. S'FOLD(mm)	6.2	1.4	4.2	10.2
SUB-SCAP. S'FOLD PERCENTILE[3]	34	24	3	93

GIRLS AGE 3 YEARS (N = 38)

Variable	Mean	Std Dev	Minimum	Maximum
AGE (month)	42.1	3.3	36	47
WEIGHT (kg)	15.3	1.7	12.2	20.0
WT. PERCENTILE[1]	50	29	3	97
WT./HT. PERCENTILE[2]	57	22	20	95
HEIGHT (cm)	98.0	3.8	91.5	107.0
HT. PERCENTILE[1]	59	28	7	97
MID-ARM CIRC. (cm)	17.1	1.0	15.0	19.3
MID-CALF CIRC.(cm)	21.9	1.4	19.5	24.5
TRICEPS S'FOLD (mm)	9.9	1.6	6.8	13.8
TRICEPS S'FOLD PERCENTILE[3]	39	20	7	90
SUB-SCAP. S'FOLD(mm)	6.1	1.2	4.0	8.8
SUB-SCAP. S'FOLD PERCENTILE[3]	41	23	3	82

REFERENCES:

1 Tanner et al (1966)
2 NCHS (1976)
3 Tanner and Whitehouse (1975).

TABLE 36 (continued)

GIRLS AGE 4 YEARS (N = 30).

Variable	Mean	Std Dev	Minimum	Maximum
AGE (months)	53.8	4.0	48	61
WEIGHT (kg)	17.6	2.2	14.2	24.9
WT. PERCENTILE[1]	53	28	10	99
WT./HT. PERCENTILE[2]	59	20	20	95
HEIGHT (cm)	106.0	5.2	98.5	117.5
HT. PERCENTILE[1]	64	27	7	99
MID-ARM CIRC. (cm)	17.5	1.0	15.9	20.7
MID-CALF CIRC. (cm)	22.8	1.1	20.3	25.2
TRICEPS S'FOLD (mm)	9.6	1.6	6.0	12.6
TRICEPS S'FOLD PERCENTILE[3]	39	20	3	75
SUB-SCAP. S'FOLD(mm)	6.0	2.2	4.2	14.8
SUB-SCAP. S'FOLD PERCENTILE[3]	35	23	7	93

TABLE 37

SUMMARY OF BOYS ANTHROPOMETRIC MEASUREMENTS, WITH COMPARISON TO ACCEPTED STANDARDS[1,2,3].

BOYS AGE 2 YEARS (N = 31).

Variable	Mean	Std Dev	Minimum	Maximum
AGE (months)	29.8	3.0	26	35
WEIGHT (kg)	14.0	1.5	11.0	18.1
WT. PERCENTILE[1]	55	29	3	99
WT./HT. PERCENTILE[2]	55	22	5	90
HEIGHT (cm)	92.1	4.3	85.3	107.4
HT. PERCENTILE	67	24	10	99
MID-ARM CIRC. (cm)	16.7	1.5	14.6	21.5
MID-CALF CIRC. (cm)	21.2	1.1	18.8	23.0
TRICEPS S'FOLD (mm)	9.1	2.1	5.8	14.4
TRICEPS S'FOLD PERCENTILE[3]	31	25	3	93
SUB-SCAP. S'FOLD(mm)	5.5	1.0	4.2	7.6
SUB-SCAP. S'FOLD PERCENTILE[3]	32	23	7	75

REFERENCES:
1 Tanner et al (1966)
2 NCHS (1976)
3 Tanner and Whitehouse (1975).

TABLE 37 (continued).

BOYS AGE 3 YEARS (N = 31)

Variable	Mean	Std Dev	Minimum	Maximum
AGE (months)	42.7	3.5	36	47
WEIGHT (kg)	16.3	1.6	14.0	19.0
WT. PERCENTILE[1]	60	25	18	97
WT./HT. PERCENTILE[2]	59	24	10	95
HEIGHT (cm)	100.3	4.1	92.1	108.3
HT. PERCENTILE[1]	64	25	18	97
MID-ARM CIRC. (cm)	17.5	1.0	15.5	20.7
MID-CALF CIRC. (cm)	22.3	1.1	20.0	23.7
TRICEPS S'FOLD (mm)	10.2	2.1	6.6	14.0
TRICEPS S'FOLD PERCENTILE[3]	55	26	10	93
SUB-SCAP. S'FOLD(mm)	5.7	1.2	4.0	8.4
SUB-SCAP. S'FOLD PERCENTILE[3]	43	24	7	90

BOYS AGE 4 YEARS (N = 35).

Variable	Mean	Std Dev	Minimum	Maximum
AGE (months)	53.5	3.7	48	61
WEIGHT (kg)	18.0	1.9	14.5	23.4
WT. PERCENTILE[1]	56	25	7	99
WT./HT. PERCENTILE[2]	57	24	10	99
HEIGHT (cm)	106.5	4.2	99.2	118.6
HT. PERCENTILE[1]	62	22	18	99
MID-ARM CIRC. (cm)	17.2	1.1	15.0	20.7
MID-CALF CIRC. (cm)	22.6	1.7	20.0	28.0
TRICEPS S'FOLD (mm)	8.8	1.7	6.6	13.2
TRICEPS S'FOLD PERCENTILE[3]	44	26	10	93
SUB-SCAP. S'FOLD (mm)	5.3	1.0	3.0	7.6
SUB-SCAP. PERCENTILE[3]	43	24	3	90

REFERENCES:
1 Tanner et al (1966)
2 NCHS (1976)
3 Tanner and Whitehouse (1975).

TABLE 38

SUMMARY OF MEAN ANTHROPOMETRIC MEASUREMENTS.

GIRLS

PARAMETER	2 YRS	3 YRS	4 YRS
Number	41	38	30
Age (months)	31	42	54
Weight (Kg)	13.5	15.4	17.6
Wt. percentile[1]	52	50	53
Wt./ht. percentile[2]	60	57	59
Height (cm)	90.3	98.0	106.0
Ht. percentile[1]	57	59	64
Mid-arm circ. (cm)	16.6	17.1	17.5
Mid-calf circ. (cm)	21.1	21.9	22.8
Triceps skinfold (mm)	9.8	9.9	9.6
Triceps percentile[3]	34	39	39
sub-scapular s'fold (mm)	6.2	6.1	6.0
sub-scapular s'fold percentile[3]	34	41	35

BOYS.

PARAMETER	2 YRS	3 YRS	4 YRS
Number	31	31	35
Age (months)	30	43	54
Weight (Kg)	14.0	16.3	18.0
Wt. percentile[1]	55	60	56
Wt./ht. percentile[2]	55	59	57
Height (cm)	92.1	100.0	106.5
Ht. percentile[1]	67	64	62
Mid-arm circ. (cm)	16.7	17.6	17.2
Mid-calf circ. (cm)	21.2	22.3	22.6
Triceps skinfold (mm)	9.0	10.2	8.9
Triceps percentile[3]	31	55	44
Sub-scapular s'fold (mm)	5.5	5.7	5.3
Sub-scapular s'fold percentile[3]	32	44	43

References.
1 Tanner et al. (1966)
2 NCHS (1976)
3 Tanner and Whitehouse (1975)

Sub-scapular skinfold thickness

The values of subscapular skinfold thicknesses for each group were plotted across the normal range for age but tended to be negatively skewed, with mean values well below the 50th percentile. As expected, mean group values of girls (6.0mm - 6.2mm) were slightly higher than those of boys (5.3mm - 5.7mm).

Correlation of anthropometric measurements taken during the first survey with the corresponding measurements taken one year later.

Very strong correlations between the first and second surveys were found for anthropometric measurements (Table 39).

The correlation coefficient of 0.97 for height was exceptionally high, demonstrating an innate ability for height to 'track' with age. For weight the correlation coefficient was slightly lower, at 0.91, illustrating a slight tendency for 'rate of weight gain with age' to vary. The percentile coefficients were slightly lower still, as recorded values of individuals were approximates, so less precise than actual weights.

The correlation coefficient of mid-arm circumference was only 0.56, suggesting either inaccuracy of measurement or a greater tendency to variation with age. The latter conclusion is assumed as this was not a particularly difficult measurement to take from young

TABLE 39

CORRELATION OF ANTHROPOMETRIC MEASUREMENTS TAKEN DURING THE INITIAL SURVEY WITH THE CORRESPONDING MEASUREMENTS TAKEN ONE YEAR LATER (N = 54).

PARAMETER	r
Height (cm)	0.97 **
Height percentile[1]	0.94 **
Weight (kg)	0.91 **
Weight percentile[1]	0.88 **
Mid-arm circumference (cm)	0.56 **
Mid-calf circumference (cm)	0.86 **
Triceps skinfold (mm)	0.66 **
Triceps percentile[2]	0.60 **
Sub-scapular skinfold (mm)	0.68 **
Sub-scapular percentile[2]	0.68 **

PEARSON CORRELATION TEST: ** $P < 0.001$
1-tailed significance.

References.

1 Tanner et al. (1966)
2 Tanner and Whitehouse (1975).

children. The coefficient for mid-calf circumference was acceptably high at 0.86.

At 0.66 and 0.68, the correlation coefficients for triceps skinfold thickness and sub-scapular skinfold thickness, for the first survey with the second survey, were surprisingly high as these measurements were difficult to take from young children with accuracy.

These results suggest that although it is more difficult to obtain accurate skinfold measurements for young children than adults, with experience it is possible to obtain reliable results. Thus skinfold readings are a simple and reliable parameter for assessing the nutritional status of young children.

Height and growth velocity measurements for the 54 children who repeated the survey after an interval of one year.

For girls and boys aged 3 and 4 years, group mean values, standard deviations and minimum and maximum values are given for each parameter measured (Table 40).

The group mean heights of girls and boys age 3 and girls age 4, was the same as for the larger groups in tables 26 and 27. The mean height of follow-up boys age 4 was slightly higher than the corresponding larger group value.

The mean height velocity percentile of girls age 3 was high at 62. For the other groups of children the mean

TABLE 40

SUMMARY OF HEIGHT AND GROWTH VELOCITY MEASUREMENTS FOR THE 54 CHILDREN WHO REPEATED THE SURVEY AFTER AN INTERVAL OF ONE YEAR.

GIRLS AGE 3 YEARS (N = 19).

Variable	Mean	Std Dev	Minimum	Maximum
AGE (months)	42	2	39	46
HEIGHT (cm)	98.1	3.8	91.5	106.8
HT. PERCENTILE[1]	58	26	10	99
HEIGHT SDS	0.31	0.85	-1.29	2.17
MID-PARENT SDS	0.17	0.67	-1.15	1.26
HT. VELOCITY (cm/year)	8.5	0.9	7.2	10.9
HT. VELOCITY PERCENTILE[1]	62	20	27	100
HT. VELOCITY SDS	0.40	0.72	-0.61	2.48

GIRLS AGE 4 YEARS (N = 9).

Variable	Mean	Std Dev	Minimum	Maximum
AGE (months)	57	5	48	61
HEIGHT (cm)	106.1	7.2	98.5	117.7
HT. PERCENTILE[1]	52	35	5	99
HEIGHT SDS	0.09	1.29	-1.62	2.25
MID-PARENT SDS	0.72	0.80	-0.54	1.82
HT. VELOCITY (cm/year)	7.0	1.2	5.6	9.4
HT. VELOCITY PERCENTILE[1]	47	34	13	100
HT. VELOCITY SDS	0.06	1.20	-1.14	2.39

BOYS AGE 3 YEARS (N = 14)

Variable	Mean	Std Dev	Minimum	Maximum
AGE (months)	41	2	39	45
HEIGHT (cm)	99.7	3.5	93.0	106.8
HT. PERCENTILE[1]	65	24	23	98
HEIGHT SDS	0.51	0.80	-0.73	2.00
MID-PARENT SDS	0.04	0.54	-0.92	0.90
HT. VELOCITY (cm/year)	7.9	1.2	5.6	9.6
HT. VELOCITY PERCENTILE[1]	50	28	4	87
HT. VELOCITY SDS	-0.03	0.87	-1.76	1.12

BOYS AGE 4 YEARS (N = 12)

Variable	Mean	Std Dev	Minimum	Maximum
AGE (months)	56	5	48	61
HEIGHT (cm)	109.8	3.7	105.0	118.6
HT. PERCENTILE[1]	71	20	36	100
HEIGHT SDS	0.83	1.12	-0.36	3.93
MID-PARENT SDS	0.42	1.02	-1.40	2.25
HT. VELOCITY (cm/year)	6.8	1.1	5.4	8.9
HT. VELOCITY PERCENTILE[1]	44	25	10	88
HT. VELOCITY SDS	-0.19	0.76	-1.30	1.18

REFERENCES 1 Tanner et al. (1966).

height velocity percentile was at, or slightly below, the 50th percentile.

A 'standard deviation score' (SDS) is an anthropometric co-ordination point, citing an individual's distance in units of standard deviation, from the mean value of a reference population (standard chart). SDS is often referred to as a 'Z score'(Smith and Booth 1989).

$$\text{SD Score} = \frac{\text{Individual value - mean value of ref. pop.}}{\text{Standard deviation value of ref.pop}}$$

The SDS values were calculated from the standard charts of Tanner et. al. (1966) using the KabiVitrum mini growth computer. By definition a 'mean' SDS should be zero. An SDS score of -1 or +1 is regarded as 'low' or 'high' respectively, and -2 or +2 as borderline of the normal range (WHO 1979).

Mid-parent height SDS (mid-parent SDS) was calculated from the mean height SDS of the mother and father. It has been used largely as a tool for comparison with the height SDS of children. An individual child's height SDS can be expected to fall within -1 or +1 SD of the mid-parent height SDS. A significant correlation of 0.37 was found for the correlation of the children's height SDS with mid-parent SDS (P<0.01).

For both height SDS and height velocity SDS no child had values of -2, though some tall and rapidly growing children had SDS values of +2 or higher.

Comparison of mean anthropometric measurements by socioeconomic group of father.

With data from the initial survey only, Table 41 compares the mean group parameters for girls and boys of socioeconomic groups I, II, IIIN, IIIM, IV and V.

Height

For both girls and boys there was no significant correlation of socioeconomic groups with height. The mean value of all groups fell above the 50th percentile.

Weight

There was no significant correlation of socioeconomic groups with mean group weight for girls and boys. However, in weight percentile terms there was a significant negative trend in weight of girls from social group I to group IV + V, with a correlation coefficient of-0.27 ($P<0.01$). This was not apparent in boys.

Weight/height percentile.

For both girls and boys there was no significant correlation of weight/height percentile with socioeconomic group. However, there was a tendency in girls for the wt/ht percentile to decline from group I to group IV + V, with a negative correlation coefficient of -0.23.

TABLE 41

COMPARISON OF MEAN ANTHROPOMETRIC MEASUREMENTS

BY SOCIOECONOMIC GROUP OF FATHER (N = 153).

GIRLS	I		II		IIIN		IIIM		IV + V		
MEAN AGE:	37 months		38 months		39 months		36 months		44 months		
NUMBER:	13		24		12		17		16		
PARAMETER:	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)	r
Height (cm)	95.7	(8.4)	96.0	(7.9)	96.9	(8.3)	94.2	(7.1)	98.2	(7.2)	.05 NS
Ht. Percentile[1]	61	(28)	62	(27)	62	(29)	64	(26)	53	(23)	-.09 NS
Weight (kg)	15.2	(2.6)	15.1	(2.2)	15.2	(2.8)	14.5	(1.8)	15.1	(2.6)	-.07 NS
Wt. Percentile[1]	64	(26)	59	(25)	52	(31)	55	(26)	39	(24)	-.27 *
Wt/Ht Percentile[2]	67	(21)	64	(17)	58	(22)	61	(21)	49	(23)	-.23 NS
Mid-arm circ. (cm)	16.8	(1.3)	17.0	(1.0)	16.8	(1.0)	17.2	(1.0)	16.7	(1.2)	-.03 NS
Mid-calf circ. (cm)	22.0	(1.5)	22.0	(1.4)	21.5	(1.7)	21.7	(1.0)	21.4	(1.8)	-.18 NS
Triceps skinfold (mm)	10.0	(1.3)	10.1	(1.8)	9.9	(2.3)	9.9	(2.1)	9.0	(1.3)	-.18 NS
Sub-scapula s'fold (mm)	6.3	(1.4)	6.0	(0.9)	5.9	(1.4)	6.9	(2.8)	5.5	(1.0)	-.18 NS

BOYS	I		II		IIIN		IIIM		IV + V		
MEAN AGE:	44 months		40 months		41 months		37 months		42 months		
NUMBER:	11		15		12		21		12		
PARAMETER:	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)	MEAN	(SD)	r
Height (cm)	99.4	(6.8)	99.1	(7.0)	97.4	(7.0)	96.4	(6.5)	100.6	(8.1)	-.04 NS
Ht. Percentile[1]	54	(20)	70	(27)	58	(21)	61	(22)	67	(29)	.08 NS
Weight (kg)	16.3	(2.6)	16.3	(2.3)	15.4	(2.4)	15.0	(2.2)	16.5	(3.0)	-.08 NS
Wt. Percentile[1]	56	(27)	66	(27)	52	(28)	52	(25)	58	(31)	-.06 NS
Wt/Ht Percentile[2]	64	(22)	64	(24)	59	(26)	53	(24)	58	(22)	-.16 NS
Mid-arm circ. (cm)	17.0	(1.1)	17.1	(1.0)	17.0	(1.2)	17.0	(1.5)	16.9	(1.6)	-.18 NS
Mid-calf circ. (cm)	23.3	(2.5)	22.0	(1.4)	21.5	(1.2)	21.5	(1.2)	22.0	(1.4)	-.11 NS
Triceps skinfold (mm)	8.0	(1.1)	9.5	(2.0)	9.2	(2.5)	9.8	(2.0)	8.7	(1.7)	-.10 NS
Sub-scapula s'fold (mm)	5.5	(1.0)	5.6	(1.1)	5.8	(1.7)	5.4	(0.9)	5.2	(0.9)	-.08 NS

STATISTICAL TEST: SPEARMAN RANK CORRELATION * $P < 0.01$ 1-tailed significance NS - not significant.

REFERENCES: 1 Tanner et al. (1966) 2 NCHS (1976).

Mid-arm and mid-calf circumferences.

For both girls and boys there was no significant correlation of mid-arm and mid-calf circumferences with socioeconomic group.

Triceps and sub-scapapular skinfold thicknesses.

For both girls and boys there was no significant correlation of triceps and sub-scapular skinfold thicknesses with socioeconomic group.

ASSESSMENT OF THE INFLUENCE OF VARIATION IN DIETARY COMPOSITION DURING EARLY CHILDHOOD ON GROWTH.

Note

Tables 42a 42b and 43 relate to correlations of mean nutrient intakes with parameters of growth for the initial survey of 153 children.

Correlation of growth and growth velocity parameters with total daily energy intake and average daily intake of macronutrients, fibre and minerals (Table 42a).

Age, height and weight were significantly correlated with mean energy intake. This was anticipated as all three variables are related to body mass, influencing basal metabolic requirements of energy.

Age

The correlation coefficient of age with energy intake was quite low, at 0.38, reflecting small increases in mean energy intake with age (Tables 20 and 21) and wide variations in energy requirements at any particular age. Intakes of fat (g), starch (g), protein (g), and iron (mg) could be expected to correlate with age, as shown, as they were highly correlated with energy intake (Table 31). Interestingly, intakes of sugar and calcium were not significantly correlated with age, though were significantly correlated with total daily energy intake (Table 31).

TABLE 42a. CORRELATION OF GROWTH PARAMETERS WITH ENERGY INTAKE AND INTAKE OF MACRONUTRIENTS, FIBRE AND MINERALS (N = 153).

	ENERGY (kcal)	FAT (g)	TOTAL CHO (g)	STARCH & DEXTRIN (g)	SUGAR(g)	PROTEIN(g)	FIBRE (g)	CALCIUM (g)	IRON (g)
AGE (months)	.38**	.29**	.31**	.38**	.14	.33**	.31**	.14	.40**
HEIGHT (cm)	.48**	.38**	.38**	.45**	.17	.43**	.39**	.24**	.42**
HT. PERCENTILE[1]	.23*	.24*	.12	.13	.06	.25**	.14	.21*	.07
WEIGHT (kg)	.53**	.42**	.42**	.52**	.18	.47**	.45**	.27**	.45**
WT. PERCENTILE[1]	.36**	.30**	.27**	.31**	.11	.34**	.29**	.25**	.23**
WT/HT. PERCENTILE[2]	.28**	.21*	.23*	.27**	.10	.24*	.22*	.15	.21*
MID-ARM CIRC. (cm)	.26*	.27**	.13	.15	.06	.24*	.11	.21*	.17
MID-CALF CIRC.(cm)	.40**	.33**	.29**	.34**	.13	.33**	.37**	.19	.37**
TRICEPS S'FOLD (mm)	-.10	-.07	-.09	-.12	-.04	-.07	-.11	-.01	-.08
TRICEPS PERCENTILE[3]	.02	.00	.03	.01	.02	.04	-.03	.05	.05
SUB-SCAP. S'FOLD(mm)	-.17	-.10	-.17	-.23*	-.04	-.12	-.13	.06	-.22*
SUB-SCAP. PERCENTILE[3]	-.01	.01	-.05	-.04	-.04	.03	-.08	.13	-.08

TABLE 42b CORRELATION OF GROWTH PARAMETERS WITH AVERAGE DAILY INTAKE OF VITAMINS (incl. supplements) (N = 153).

	VIT. B1	VIT. B2	VIT. B6	VIT. B12	VIT. A(L)	VIT. D(L)	VIT. E(L)	VIT. C(L)
AGE (months)	.42**	.18	.28**	.07	.08	.08	.24*	.15
HEIGHT (cm)	.44**	.18	.27**	.12	.10	.07	.23*	.13
HT. PERCENTILE[1]	.08	.01	.01	.13	.06	.00	.05	-.02
WEIGHT (kg)	.49**	.22*	.34**	.16	.11	.10	.30**	.16
WT. PERCENTILE[1]	.28**	.15	.17	.14	.08	.08	.20*	.08
WT/HT PERCENTILE[2]	.26**	.17	.21	.10	.08	.06	.22*	.13
MID-ARM CIRC. (cm)	.25*	.29**	.05	.23*	.13	.06	.13	.07
MID-CALF CIRC.(cm)	.38**	.26*	.17	.05	.02	.05	.26*	.13
TRICEPS S'FOLD (mm)	.02	.06	-.01	.07	.00	.00	.00	.05
TRICEPS PERCENTILE[3]	.15	.14	.05	.11	.01	.01	.04	.06
SUB-SCAP. S'FOLD(mm)	-.11	.07	-.07	.02	.05	.08	.04	.09
SUB-SCAP. PERCENTILE[3]	.04	.15	.01	.11	.04	.05	.09	.04

PEARSON CORRELATION TEST: * P < 0.01 ** P < 0.001 1-tailed significance. (L) Logarithmic transformation.

REFERENCES: 1. Tanner et al (1966) 2. NCHS (1976) 3. Tanner and Whitehouse (1975).

Height and Weight

The correlation coefficients for height and weight with intake of energy, macronutrients and minerals were very similar, i.e. correlations of 0.48 and 0.53 for height and weight respectively with energy intake. Weight had a marginally higher association than height with nutrient intakes. For both parameters the correlation of actual height or weight with nutrient intake was much stronger than the correlation with age related percentile values. There was a significant correlation of height and weight with intake of all nutrients cited, except sugar.

Mid-arm and mid-calf circumferences

There was a much stronger association of nutrient intake with mid-calf circumference than with mid-arm circumference, suggesting that in British children, mid-calf circumference is a more reliable indicator of nutritional status than mid-arm circumference.

Triceps and sub-scapular skinfold thicknesses

There were few associations between nutrient intake and measurement of skinfold thicknesses, apart from low but significant negative correlations of starch and iron intake with subscapular skinfold readings.

Fibre, iron and calcium.

Intakes of fibre, iron and calcium were highly correlated with height (cm) and weight (kg) ($P<0.001$); and, although the correlations were weaker, weight percentile ($P<0.001$) (Table 42a). This may be partially because the correlation coefficients for energy intake with these nutrients were high at 0.49, 0.69 and 0.54 respectively (Table 31). Thus children with larger body masses and therefore larger energy requirements would have had a coincidental higher intake of these nutrients. Furthermore, as intake of fibre, iron and calcium were not correlated with growth velocity it is suggested that correlation of intake of these nutrients with parameters of attained growth was due to a coincidental association with energy intake, rather than to growth promotion or inhibition occurring over the estimated range of daily intakes (Table 44).

Correlation of growth parameters with average daily intake of vitamins (incl. supplements)(N = 153)(Table 42b).

Only vitamin B1, vitamin B6 and vitamin E were highly correlated with age and anthropometric parameters (Table 42b) . This may be partly because the correlation coefficients for energy intake with these vitamins were also high at 0.53, 0.47 and 0.47 respectively, whilst correlation of energy intake with other vitamins was lower (Table 31). Thus children with a larger body mass and therefore larger energy requirements had a coincidental higher intake of vitamins B1, B6 and E.

The strong correlations of vitamins B1, B6 and E with height (cm) (0.44, 0.27 and 0.23 respectively) and weight (kg) (0.49, 0.34 and 0.30 respectively) are of note as the corresponding correlations for vitamin B1, B6 and E with height and weight percentiles are much weaker. This further suggests that correlation of these nutrients with growth parameters is coincidental to higher intakes of energy, rather than to associated growth promotion or inhibition occurring over the estimated range of daily intakes.

There was no significant association of height percentile with intake of any vitamin, suggesting that the low vitamin intakes of the small minority of children who barely attained LRNI levels were adequately sustaining growth.

Correlation of growth parameters with intake of macronutrients, expressed as a % of energy intake.

Apart from a mildly significant positive correlation of starch intake with weight, there was no association of % of energy from fat, starch, sugar or protein on parameters of growth (Table 43). Thus there was no significant tendency for children on a low fat diet to be smaller than those on a high fat diet, and similarly for intakes of sugar, starch and protein.

TABLE 43

CORRELATION OF GROWTH PARAMETERS WITH INTAKE

OF MACRONUTRIENTS, EXPRESSED AS % OF ENERGY INTAKE.

	% OF ENERGY FROM:				
	FAT	TOTAL CHO	STARCH & DEXTRIN	SUGAR	PROTEIN
N = 153					
AGE (months)	.00	-.02	.15	-.10	.07
HEIGHT (cm)	.02	-.06	.15	-.13	.12
HT. PERCENTILE[1]	.10	-.12	-.04	-.07	.12
WEIGHT (kg)	.01	-.05	.19*	-.16	.12
WT. PERCENTILE[1]	.04	-.07	.08	-.11	.12
WT./HT. PERCENTILE[2]	-.02	-.01	.10	-.07	.05
MID-ARM CIRC. (cm)	.13	-.15	-.05	-.08	.08
MID-CALF CIRC.(cm)	.07	-.09	.08	-.12	.08
TRICEPS S'FOLD (mm)	-.02	.02	-.07	.05	-.01
TRICEPS PERCENTILE[3]	-.06	.05	-.02	.04	.01
SUB-SCAP. S'FOLD(mm)	.03	-.03	-.17	.10	-.01
SUB-SCAP. PERCENTILE[3]	.04	-.06	-.04	-.02	.05

PEARSON CORRELATION TEST: * P < 0.01 1-tailed significance.

REFERENCES

1 Tanner et al (1966)
2 NCHS (1976)
3 Tanner and Whitehouse (1975).

Correlation of growth percentiles and growth velocity parameters with the average daily nutrient intake from the initial and repeat surveys (N = 54).

If nutrient intake is expressed as the average of the initial and repeat surveys, a better representation of usual intake throughout the year is achieved than either of the individual surveys, giving more appropriate values for correlation with height velocity data. In this manner Table 44 correlates the average nutrient intakes of 54 children with percentiles of growth and parameters of growth velocity. The average nutrient intake has also been correlated with height and weight percentiles for comparison with Tables 42a and 42b, based on the initial 7-day dietary survey of the total group of 153 children.

Averaged intakes of energy (kcal), fat (g), total CHO (g), starch (g) and protein (g) were significantly correlated with height and weight percentiles, as in Table 42a. A significant correlation of 0.39 ($P<0.01$) was obtained for sugar (g) with weight percentile, unlike the correlation of sugar intake with weight percentile in Table 42a which was not significant.

The correlations of wt/ht percentile with the average nutrient intakes from the initial and repeat survey did not reach levels of significance (Table 44), in contrast to the low, but significant correlations found in Table 42a.

TABLE 44

CORRELATION OF GROWTH PERCENTILES AND GROWTH VELOCITY PARAMETERS

WITH THE AVERAGE DAILY NUTRIENT INTAKE FROM THE INITIAL AND REPEAT SURVEYS (N = 54).

NUTRIENT	HEIGHT PERCENTILE[1]	WEIGHT PERCENTILE[1]	WT/HT PERCENTILE[2]	HEIGHT VELOCITY	HEIGHT VEL. PERCENTILE[1]	HEIGHT VEL. SDS
Energy (kcal)	.50**	.56**	.20	.03	.18	.17
Fat (g)	.35*	.40**	.17	-.03	.08	.06
Total CHO (g)	.44**	.51**	.17	.07	.18	.19
Starch (g)	.34*	.36*	.03	-.02	.09	.09
Sugar (g)	.31	.39*	.19	.09	.15	.16
Protein (g)	.52**	.47**	.13	.05	.23	.22
Fibre (g)	.29	.36**	.12	.09	.11	.11
Calcium (g)	.38*	.38*	.10	.01	.10	.08
Iron (g)	.20	.22	.02	-.01	.08	.11
Vitamin B1 (mg)	.30	.36*	.12	-.08	.08	.08
Vitamin B2 (mg)	.07	.22	.26	-.10	.00	.00
Vitamin B6 (mg)	.23	.20	.03	.15	.21	.20
Vitamin B12 (mcg)	.23	.25	.15	.05	.09	.05
(L)Vitamin A (ret.eq.mcg)	.08	.15	.16	.10	.09	.09
(L)Vitamin D (mcg)	.17	.23	.19	.05	.12	.14
(L)Vitamin E (a-T-eq mg)	-.10	.09	.39*	-.12	-.15	-.12
(L)Vitamin C (mg)	.22	.20	.09	.21	.15	.18
<u>% of energy from:</u>						
FAT	-.06	-.07	.00	-.09	-.10	-.14
TOTAL CHO	-.05	.00	-.02	.05	.03	.06
STARCH	-.01	-.06	-.16	-.02	.00	.00
SUGAR	-.03	.05	.12	.05	.01	.03
PROTEIN	.32	.14	-.04	.07	.19	.19

PEARSON CORRELATION TEST: * P < 0.01 ** P < 0.001 (L) Logarithmic transformation

REFERENCES: 1. Tanner et al (1966) 2. NCHS (1976).

As also found in Table 43, the average macronutrient intakes from the two surveys, expressed as a % of energy intake, did not significantly correlate with percentiles of height and weight (Table 44).

There were no significant correlations of height velocity parameters with the average intake of nutrients, by weight, or with intake of macronutrients, expressed as a % of energy intake. Thus variations in nutrient intake, and of the composition of the diet, apparently had no influence on rate of growth in our cohort of children.

Growth parameters of children with a height velocity percentile of < 30.

Of the 54 children who repeated the study, four girls and six boys had a low height velocity percentile of <30, and thus were classified as having a poor rate of growth. Table 45 displays the growth parameters of these individual children for examination.

G1 and G2 were identical twins. They had very low height percentiles and a height SDS of -2 in relation to their mid-parent SDS. Their height velocity was low. These girls were not malnourished, as testified by a high wt/ht percentile of 75/80. Their diet was very adequate. In view of their tall parents, they may have had a growth retarding congenital condition, though not of great concern if their height and rate of growth remain within the normal range.

TABLE 45 COMPARISON OF GROWTH PARAMETERS WITH THE DIET OF CHILDREN WHO HAD A LOW HEIGHT VELOCITY PERCENTILE OF < 30.

Reference	Age (months)	Height Percentile(1)	Height SDS	Mid-parent SDS	Ht. velocity Percentile(1)	Ht. velocity SDS	Wt./Ht. Percentile(2)	DIET
GIRLS								
G1	58	5	-1.62	0.49	26	-0.64	75	Adequate
G2	58	7	-1.51	0.49	13	-1.14	80	Adequate
G3	48	39	-0.27	0.43	23	-0.73	30	Low quantity
G4	59	20	-0.86	-0.19	17	-0.95	50	Adequate
BOYS								
B1	45	50	0.00	-0.36	10	-1.29	95	Low vit C, B2
B2	39	23	-0.73	0.23	27	-0.61	50	Very poor
B3	58	53	0.08	0.65	11	-1.25	60	Good
B4	60	72	0.58	-0.41	26	-0.65	80	Good
B5	57	91	1.38	1.06	10	-1.30	60	Excellent
B6	43	60	0.25	-0.92	22	-0.77	90	Excellent

COMMENTS.

G1/2 G1 and G2 are identical twins. Possible growth-retarding congenital condition?

G3 The diet of G3 was low in quantity, not quality. Unknown quantities of breast-milk were not included in the dietary analysis.

G4 The diet of G4 was adequate. Parental separation within previous year.

B1 The diet of B1 was low in vitamin C, B vitamins and calcium. Over the previous year eating habits had become disorganised, with frequent snacks, as both parents were working irregular full-time shifts. A vitamin A D and C supplement was taken.

B2 The diet of B2 was extremely poor due to very fussy eating habits. Whilst concerned, the mother 'gives him what he wants'.

B3/4 The diets of B3 and B4 were good. Stable social backgrounds. Both take a multivitamin supplement. The parents of B4 are small.

B5 The diet of B5 was excellent. Social background apparently stable. A difficult, wriggly child: inaccuracies in measurements?

B6 Diet excellent. Difficult social circumstances. Ever increasing large young family. Both parents are small.

REFERENCES: 1 Tanner et al. (1966) 2 NCHS (1976).

G3 was not particulary small for age, with a height percentile of 39. Though mid-parent SDS is 0.43 her mother was very small and her father very tall. Of concern was a low wt./ht. percentile of 30, in relation to a low ht. vel. percentile of 23. This child did not eat a great deal so has a low energy intake; she was however, still receiving small amounts of breast milk. Ideally, the diet and growth of this child should be monitored.

G4 was quite small for age, with a height percentile of 20, however her rate of growth was poor, with a height velocity percentile of only 17. Height SDS was low at -0.86, though not exceptionlly low in relation to her mid-parent SDS of -0.19. The diet of this child was adequate, and weight for height average. This child may be of genetically determined small stature. Alternatively, the trauma of parental separation during the year of study may have temporarily inhibited growth.

B1 is an interesting case. He was a lively tubby child of average height. However, during the year of study his height dropped from the 75th to the 50th percentile. His height velocity was exceptionally low on the 10th percentile. Poor growth coincided with a period of disrupted family life. His parents worked irregular full-time shifts, so as a family they were rarely together. Their house was in the process of major structural alterations during the study year. The child tended to eat alone, often on snacks of 'bread and honey', provided by childminder, mother or father. The mother, voluntarily, expressed concern at the child's poor diet, that was brought to her attention by the study. Whilst a combination of poor diet and trauma may have retarded this child's growth, there may be an underlying clinical condition. Although this child outwardly appears 'normal', he gives cause for concern.

B2 was a small child on the 23rd height percentile with a low height velocity percentile of 27, though with an average wt/ht percentile of 50. As he is an extremely fussy child his diet was very restricted, low in protein, vitamins B1, B6, B12, niacin and vitamin E. Though his poor diet may have contributed to a small stature, he was still within the normal height range for age and growing at a low but acceptable rate, so may be of a genetically determined small stature.

B3 was of average height with an average wt/ht percentile, had a good diet, a stable family life and tall parents. For no apparent reason his height velocity was very low, on the 11th percentile. He was not a difficult child to measure. Ideally, this child should be monitored as poor growth may be an early symptom of an underlying clinical condition or trauma.

B4 was a child with an above average height and a high wt/ht percentile, an excellent diet and a stable family life. Though his rate of growth was quite low, on the 26th percentile, it was not a great cause of concern as both parents are small, so he may have a genetic tendency towards smaller stature.

B5 is a tall child of tall parents with an average wt/ht percentile of 60. Diet is excellent. Height velocity is low, on the 10th percentile. This child may have an underlying growth retarding clinical condition, however as he was a particularly difficult and wriggly child it is highly possible that measurements were inaccurate, resulting in measurement errors.

The height percentile of B6 was above average and wt/ht percentile high. However, the height velocity percentile was low at 22. This child's height SDS at 0.25 was high in relation to the mid-parent height SDS of -0.92. Thus B6 may have had a genetic tendency to small stature affecting rate of growth. Alternatively, the child lived in difficult social circumstances, part of a large, young and very disorganised family, which may have had a traumatic effect on growth.

Conclusion

Of the 54 children for whom growth velocity data is available, 10 (18.5%) had a low height velocity percentile of <30. Examination of the data for individual children suggested a variety of reasons for a slow rate of growth such as congenital conditions, genetic tendency, clinical conditions, poor diet and traumatic social circumstances. Without follow-up growth velocity data and clinical examination no definitive cause can be identified for any particular child having a poor growth velocity. Only three children with poor growth velocity had diets of questionable adequacy. Of these three children, two had adequate energy intakes but a poor quality diet, the reverse was true for the other child. The rate of growth of the remaining 44 children (81.5%) was adequate.

Though some diets provided little more than the LRNI of vitamins and minerals, and several children apparently had very low intakes of energy, it is concluded that diet did not significantly impair rate of growth in the children studied.

Studies of the relationship between nutrition and growth in selected sub-groups of children.

Tables 46 to 50 are based on the growth parameters and nutrient intake of the 153 children studied during the initial survey only. Each table takes a specific aspect of diet and compares the anthropometric parameters of children from either extreme. Groups are statistically compared using the non-parametric Mann-Whitney U-test, as this is a more suitable test for the comparison of small groups of subjects.

Comparison of growth parameters and nutrient intake of children taking a LOW FIBRE DIET to those taking a HIGH FIBRE DIET.

There are no accepted levels of fibre intake with which to categorise children into low or high groups. The bottom 11% of cases (<6.5g fibre) and top 11% of cases (>13.5g fibre) have been taken as they produced groups of a suitable size of 17 for comparison with each other (Table 46).

<u>Anthropometric parameters</u>

The group mean age of children taking a high fibre intake was almost one year older than children taking a low fibre diet, partly accounting for the significant differences in height and weight found between the two groups. Taking percentile values, there was no signficant difference in percentiles of height or skinfold measurements between the two groups. However, children on a low fibre diet were significantly lighter than children on a high fibre diet, with mean weight percentiles of 47 and 72 respectively ($P<0.01$). There was also a weakly significant difference between the wt/ht percentiles of the two groups ($P<0.05$).

<u>Nutrient intake</u>

Children on a low fibre diet had a group mean fibre intake of 5.3g/day, those on a high fibre diet had a group

TABLE 46

COMPARISON OF THE GROWTH PARAMETERS AND NUTRIENT INTAKE OF CHILDREN TAKING A LOW FIBRE DIET (bottom 11% cases/ N=17) TO THOSE TAKING A HIGH FIBRE DIET (top 11% cases/ N=17).

	LOW FIBRE		HIGH FIBRE		
Number	17		17		
Male : female ratio	5:12		13:4		
Anthropometric Parameters	Mean	(SD)	Mean	(SD)	
Age (months)	34	(8)	45	(10)	
Height (cm)	92.9	(5.9)	102.0	(7.6)	**
Height percentile[1]	62	(24)	69	(26)	NS
Weight (kg)	13.8	(1.8)	17.4	(2.6)	**
Weight percentile[1]	47	(25)	72	(23)	*
Triceps s'fold percentile[2]	42	(28)	52	(27)	NS
Sub-scapular s'fold 'centile[2]	35	(29)	32	(23)	NS
Wt./Ht. percentile[3]	54	(22)	70	(19)	$
Nutrient Intake					
Dietary fibre (g)	5.3	(0.7)	14.9	(1.1)	**
Energy (kcal)	983	(204)	1269	(182)	**
% energy from fat	38	(5)	33	(6)	$
% energy from sugar	30	(6)	28	(7)	NS
% energy starch & dextrin	18	(5)	25	(3)	**
% energy from protein	13	(2)	13	(2)	NS
P:S ratio	.19	(.05)	.37	(.15)	**
Iron (mg)	4.2	(0.8)	7.9	(2.0)	**
Calcium (mg)	674	(243)	631	(271)	NS
Thiamin (mg)	0.5	(0.1)	0.9	(0.2)	**

$ P < 0.05   * P < 0.01   ** P < 0.001   NS not signifiant

Comparison is by Mann-Whitney U - tests (2-tailed signif).

References

1 Tanner et al. (1966)
2 Tanner and Whitehouse (1975)
3 NCHS (1976).

mean intake of 14.9g/day. Though the energy intake of the two group was significantly different, age was a contributing factor. Of interest was the differences in macronutrient intake, expressed as % of energy intake.

Children on a low fibre diet had a significantly higher mean % of energy from fat (38%) than children on a high fibre diet (33%) ($P<0.05$).

Children on a high fibre diet had a significantly higher mean % of energy from starch (25%) than children on a low fibre diet (18%) ($P<0.001$). There was no significant difference in sugar intake between the groups.

The P:S ratio of the high fibre group was significantly higher than that of the low fibre group ($P<0.001$).

Of interest was the significantly higher intake of iron and thiamin of children taking a high fibre diet. This was related to a significantly higher % of energy form starch, as there was a significant correlation of starch intake, from bread and cereals, with intake of iron and thiamin ($P<0.001$) (Table 33).

Conclusion

This study found no evidence to support the view that children who take a high fibre diet are unable to maintain energy intake or growth. On the contrary, children taking a high fibre diet were significantly heavier than those taking a low fibre diet and had a significantly higher intake of iron and thiamin.

Comparison of the growth parameters and nutrient intake of children taking a LOW FAT DIET to those taking a HIGH FAT DIET.

From the initial study of 153 children, those taking less than 30% of energy from fat were categorised as having a Low Fat diet (LF) n = 20; and those taking more than 40% of energy from fat were categorised as having a High Fat diet (HF) n = 23.

Anthropometric parameters

Both LF and HF children were of a comparable age, at 40 and 39 months respectively. There were no statistically significant differences between the mean group anthropometric parameters, suggesting that the mean body composition of the two groups was very alike.

Nutrient intake

The mean energy intake of both the LF and HF groups was very similar, at 1175 kcal and 1192 kcal respectively, thus not significantly different. However, the composition of their diets varied considerably.

The mean % of energy from fat of the LF group was 28% and that of the HF group 43%. Children from the LF group maintained their energy intake by increasing their intake of sugar and starch. The sugar intake of the LF group was extremely high at 36% of energy, compared to a sugar intake by the HF group of 23% of energy ($P<0.001$).

TABLE 47

COMPARISON OF THE GROWTH PARAMETERS AND NUTRIENT INTAKE OF CHILDREN TAKING A <u>LOW FAT DIET</u> (< 30% energy from fat) TO THOSE TAKING A <u>HIGH FAT DIET</u> (> 40% energy from fat).

	LOW FAT		HIGH FAT		
Number	20		23		
Male : female ratio	11:9		10:13		
	Mean	(SD)	Mean	(SD)	
Anthropometric parameters					
Age (months)	40	(10)	39	(10)	NS
Height (cm)	98.6	(6.8)	97.3	(7.8)	NS
Ht. percentile[1]	65	(30)	68	(22)	NS
Weight (kg)	15.8	(2.4)	15.5	(2.6)	NS
Wt. percentile[1]	60	(31)	60	(30)	NS
Mid-arm circumference (cm)	17.1	(1.1)	17.1	(1.1)	NS
Mid-calf circumference (cm)	22.0	(1.9)	22.0	(1.6)	NS
Sub-scapular skinfold (mm)	5.8	(1.5)	5.7	(1.2)	NS
Triceps skinfold (mm)	9.7	(1.9)	9.3	(1.9)	NS
Wt./Ht. percentile[2]	61	(24)	60	(24)	NS
Nutrient intake					
Energy (kcal)	1175	(174)	1192	(269)	NS
% energy from fat	28	(2)	43	(2)	**
% energy from sugar	36	(6)	24	(4)	**
% energy starch & dextrin	23	(5)	19	(5)	*
% energy from protein	12	(1)	13	(2)	NS
P:S ratio	.31	(.13)	.23	(.13)	$
Fat (g)	36.3	(6.6)	56.7	(13.2)	**
Dietary fibre (g)	11.7	(3.2)	8.9	(3.9)	$
Vitamin A (ret. eq. mcg)	373	(183)	687	(427)	*
Vitamin D (mcg)	1.2	(0.6)	1.2	(0.7)	NS
Vitamin C (mg)	73	(50)	29	(18)	**
Calcium (mg)	513	(126)	774	(262)	

$ P < 0.05   * P < 0.01   ** P < 0.001   NS not significant

Comparison is by Mann-Whitney U - tests (2-tailed signif.)

<u>References.</u>

1 Tanner et al. (1966)
2 NCHS (1976).

The mean % of energy from starch of the LF group, at 23%, was significantly higher (P<0.01) than the mean % of energy (19%) from starch of the HF group. There was a mildly significant difference (P<0.05) in fibre intake, with the LF group taking a little more fibre (11.7g/day) than the HF group (8.9g/day).

There were significant differences in the intake of vitamins A, C, and of calcium. The LF group had a significantly lower intake of vitamin A than the HF group, largely because they drank less full-fat milk than the HF group (Table 48). However, at 373 mcg/day the mean vitamin A intake of the LF group was only slightly lower than the RNI of 400 mcg/day and higher than the EAR of 300 mcg/day, suggesting that the group intake was adequate (Table 47).

The vitamin C intake of the LF group was significantly higher than the mean intake of the HF group. This is because children taking a low fat diet tended to drink large amounts of Ribena and pure fruit juice (Table 48). As the RNI of vitamin C is 30 mg/day, intake of the HF group was adequate at a mean intake of 29 mg/day. Though children on a low fat diet drank semi-skimmed milk and ate more yoghurt than those on a high fat diet (Table 48), they still had a significantly lower intake of calcium. However, with a mean calcium intake of 513 mg/day, the LF group were taking much more than RNI of 350 mg/day.

Conclusion

This study found no evidence to support the view that a low fat diet impairs energy intake or growth in pre-school children. No significant differences in anthropometric parameters were apparent between children taking an LF or HF diet. There were no significant difference in energy intake. The composition of the diet did vary, as children on a LF diet were taking significantly more sugar, starch, fibre and vitamin C than those on an HF diet, and less vitamin A and calcium.

Comparison of the main sources of energy of children taking Low Fat and High Fat diets.

The main sources of energy of children taking a Low Fat diet (LF) or High Fat diet (HF) are compared in Table 48.

There were considerable differences in the intake of dairy products. Children on a high fat diet had a mean intake of approximately 21% of energy from full-fat milk, equivalent to an approximate intake of 400 ml milk, used for drinking and on breakfast cereals. Children on a low fat diet had a mean intake of approximately 75 ml semi-skimmed milk and 65 ml full-fat milk, used largely on breakfast cereals. Children on a low fat diet also had a tendency to eat more yoghurt and less full-fat cheese than those on a high fat diet.

Children on a low fat diet partially maintained their energy intake by eating more bread, and had a

TABLE 48

MAIN SOURCES OF ENERGY OF CHILDREN TAKING A LOW FAT DIET (< 30% energy from fat) AND A HIGH FAT DIET (> 40% energy from fat).

	Approximate % of ENERGY.	
Sources:	Low fat	High fat.
Full-fat milk	3.5	21.0
Semi-skimmed milk	2.5	0.5
Yoghurt	4.5	1.0
Butter and margarine	3.0	4.0
Cheese	0.5	2.0
Breakfast cereals	6.0	2.0
Breads: White	5.0	3.5
Wholemeal/brown	2.5	1.5
Biscuits and cakes	3.5	5.0
Pure fruit juice	3.5	0.5
Ribena	4.5	neg
Orange squash	1.0	1.0
Fruit drinks (eg.Five Alive)	2.5	neg
Lemonade/cola	1.5	0.5
Chocolate and sweets	5.5	5.0
Meat products	3.0	4.5
Chips	2.0	3.0
Crisps	3.0	4.5
Potato	1.5	1.0
Other foods:	40%	40%

surprisingly high intake of breakfast cereals compared to the HF group.

Perhaps the most startling difference between the two groups was the high intake of sugar from pure fruit juice, Ribena and lemonade taken by children on a low fat diet, altogether contributing approximately 13% of energy.

There were other small differences in sources of energy between the two groups. Children on a low fat diet ate a little less meat products (eg pies, burgers), chips and crisps than those on a high fat diet and ate a little more boiled/baked potato.

The foods mentioned above together contributed approximately 60% of energy. The remaining 40% of energy was derived from small amounts of meat, fish, egg, fruit, vegetables and miscellaneous items, with no readily identifiable differences between the groups.

Comparison of the growth parameters and nutrient intake of children taking a LOW FIBRE + HIGH FAT DIET (A) to those taking a HIGH FIBRE + LOW FAT DIET (B).

The aim of this study was to test the hypothesis that young children have difficulty in obtaining sufficent energy from high fibre + low fat diets as they are bulky and have a low energy density.

From the initial study of 153 children, those taking <6.5g fibre + >40% energy from fat were categorised (A), as having a high energy dense diet, and those taking >13.5g fibre + <30% energy from fat were categorised (B) as taking a low energy dense diet. Only small numbers of children attained these stringent conditions, 7 in group (A) and 6 in group (B), (Table 49).

<u>Anthropometric parameters</u>

As the composition of these small groups were quite different in terms of age and sex only growth percentiles have been cited.

There was no significant difference in the mean height percentiles of the two groups, though there was a difference in weight, as children in group B were significantly heavier than those children in group A ($P<0.01$), shown in terms of weight percentile and wt/ht percentile.

TABLE 49

COMPARISON OF THE GROWTH PARAMETERS AND NUTRIENT INTAKE OF CHILDREN TAKING A LOW FIBRE + HIGH FAT DIET (A) (<6.5g fibre + >40% energy fat), TO THOSE TAKING A HIGH FIBRE + LOW FAT DIET (B) (>13.5g fibre + <30% energy fat).

Group	(A)		(B)		
Number	7		6		
Anthropometric parameters	Mean	(SD)	Mean	(SD)	
Age (months)	35	(9)	41	(11)	
Height percentile[1]	67	(15)	66	(25)	NS
Weight percentile[1]	43	(23)	79	(9)	*
Ht./WT. percentile[2]	47	(18)	81	(7)	*
Nutrient intake					
Energy (kcal)	1051	(250)	1243	(160)	NS
% energy from fat	43	(2)	28	(2)	*
% energy from sugar	26	(4)	34	(5)	$
% energy starch & dextrin	15	(4)	25	(4)	*
P:S ratio	.17	(.05)	.42	(.16)	*
Dietary fibre (g)	5.1	(0.8)	15.4	(1.2)	*
Iron (mg)	3.9	(0.8)	8.2	(2.3)	*
Vitamin A (ret.eq.mcg)	875	(595)	325	(39)	*
Vitamin D (mcg)	0.9	(0.4)	1.4	(0.6)	NS

$ P < 0.05   * P < 0.01   ** P < 0.001   NS not significant

Comparison is by Mann-Whitney U - tests (2-tailed signif).

References

1 Tanner et al. (1966)
2 NCHS (1976).

Nutrient intake

There were no significant differences in energy intake between the groups. The slightly higher intake of group B was possibly related to the mean difference in age of 6 months between the groups.

Children in group A had a significantly higher intake of vitamin A, though the mean intake of group B was above the EAR of 300 mcg/day. Children from group B had a significantly higher intake of starch and iron ($P<0.01$) than children in group A, and a higher % of energy from sugar ($P<0.05$).

Conclusion

The results of this study suggest that children taking a low energy dense diet of >13.5g fibre + <30% energy from fat can obtain sufficient energy from their diet to maintain growth.

Comparison of the growth and nutrient intake of children taking either FULL-FAT milk or SEMI-SKIMMED milk during the previous year.

From the initial dietary survey, children were grouped according to the type of milk they were reported to have been taking regularly during the previous year. Of the 153 children, 95 were taking full-fat milk, 25 semi-skimmed milk and the remaining 33 either very little milk or a mixture of types. Table 50 compares the nutrient intake and growth parameters of children taking full-fat milk and semi-skimmed milk. Comparison by both independent t-tests and Mann-Whitney U-tests produced the same results.

Anthropometric parameters

The mean age of both groups of children was very similar, at 38 and 41 months. There were no significant difference between the groups for any parameter of growth. Children taking semi-skimmed milk compared very favourably with those taking full-fat milk, having slightly higher mean percentiles of height and weight.

Nutrient intake

There were no significant differences in energy intake between the two groups of children though there were significant differences in the composition of the diet.

TABLE 50

COMPARISON OF THE GROWTH AND NUTRIENT INTAKE OF CHILDREN TAKING EITHER FULL-FAT (4% fat) or SEMI-SKIMMED (2% fat) MILK DURING THE PREVIOUS YEAR.

GROUP	FULL-FAT		SEMI-SKIMMED		
Number	95		25		
Male : female ratio	4:5		14:11		
Anthropometric parameters	Mean	(SD)	Mean	(SD)	
Age (months)	38	(10)	41	(11)	
Height (cm)	96.3	(7.5)	99.3	(7.5)	NS
Ht. percentile[1]	61	(26)	67	(5.2)	NS
Weight (kg)	15.2	(2.4)	16.2	(2.5)	NS
Wt. percentile[1]	56	(27)	64	(28)	NS
Triceps skinfold (mm)	9.6	(2.0)	9.9	(1.6)	NS
Sub-scapular skinfold (mm)	6.0	(1.6)	6.0	(1.3)	NS
Mid-calf circumference (cm)	21.8	(1.4)	21.9	(1.5)	NS
Mid-arm circumference (cm)	17.0	(1.2)	17.1	(1.1)	NS
Nutrient intake					
Energy (kcal)	1107	(207)	1174	(201)	NS
% energy from fat	36	(5)	32	(5)	**
% energy from SFA	16	(3)	13	(2)	**
% energy from sugar	29	(6)	31	(6)	NS
% energy starch & dextrin	20	(5)	24	(4)	**
P:S ratio	.24	(.09)	.35	(.12)	**
Vitamin A (ret.eq.mcg)	527	(302)	365	(197)	*
Vitamin D (mcg)	1.0	(0.6)	1.4	(0.8)	NS
Calcium (mg)	650	(208)	574	(181)	NS

* P < 0.01 ** P < 0.001 NS not significant

Comparison is by independent t-tests, (2-tailed signif.)

Reference 1 Tanner et al. (1966).

Children taking semi-skimmed milk had a significantly lower % of energy from fat (32%) than children taking full-fat milk (36%) (P<0.001). They also obtained a significantly higher % of energy from starch, 24% and 20% respectively (P<0.001). The % of energy from sugar was not significantly different between the two groups, children taking semi-skimmed milk derived only 2% more energy from sugar than children taking full-fat milk.

The mean vitamin A intake of children taking semi-skimmed milk was lower than those taking full-fat milk, but at 365 mcg/day was higher than the EAR of 300 mcg/day and not markedly lower than the RNI of 400 mcg/day. The mean calcium intake of children taking semi-skimmed milk was also lower, though at 574 mg/day, their mean intake was well above the RNI of 350 mg/day.

Conclusion

This study found no difference in growth parameters between children taking full-fat milk and those taking semi-skimmed milk. Though energy intake was not significantly different, there were differences in the composition of the diet. Children using semi-skimmed milk had a lower intake of fat and a higher intake of starch than those using full-fat milk. They had adequate intakes of vitamin A and calcium and were not taking significantly more sugar than children using full-fat milk.

CHAPTER 4 DISCUSSION

The relationship between nutrient intake and growth in pre-school children is a topic that merits rigorous scientific investigation as the pre-school period is critical to the development of childrens' lifelong eating habits and their health and well-being (Lennon and Fieldhouse 1982, Kwiterovich 1986, Lloyd 1991, Wright 1991).

This research addresses the need for up-to-date information on the eating habits of pre-school children and of the relationship between nutrient intake and growth. It provides data on the normal nutrient intake of UK pre-school children, including for the first time information on the intake of fibre and fatty acids. The data also supplements a paucity of information on sugar intake. Anthropometric measurements illustrate the apparent changes in body composition of children since the current standard charts were prepared 25 years ago (Tanner et al 1966, Tanner and Whitehouse 1975).

This study of 'Nutrient Intake and Growth in Pre-school Children' is a major dietary survey of young British children. It is the most thorough and comprehensive investigation yet undertaken of the influence of dietary composition on nutrient intake and growth, as quality of diet is examined in relation to proportion of energy from macronutrients, and the influence of nutrient intake on the velocity of growth is also assessed.

SAMPLE RECRUITMENT

This study of 153 children, of whom 54 were repeated one year later to give a total of 207 dietary surveys, is the second largest study of UK pre-school children ever to be undertaken. Whilst an initial response of 33% to the letter of invitation to participate in this study may appear low, given the intense nature of the study it was anticipated, and accommodated, ensuring an adequate sample size. No attempt was made to coerce mothers into participating in the study by sending a follow-up letter of invitation, as this may have been regarded as placing 'undue pressure' on mothers by local General Practitioners and Health Visitors concerned with the welfare of mothers. There is little comparable data on pre-school children with which to compare the response rate. Previous surveys report a higher rate of participation by verbally inviting cooperation in a clinical setting, a method that was not feasible for this study. Black et al. (1976) reports a 96% response to a study of growth, whilst Bransby and Fothergill (1954) successfully recruited 60% of a sample of pre-school children for a weighed dietary survey. Recent surveys of school-aged children have found variable levels of response. Kirk (1991, verbal communication) reports a low response rate of 35% to a weighed dietary survey of school aged children in Edinburgh, also invited to participate by letter. McNeill et al (1991) obtained a response rate of 65% on inviting 12 year old children to participate in a dietary survey, though only a proportion of children completed the survey, giving a final response rate of 30%. In adults response rates are often quoted as 70% - 80% (Bingham 1987), however ethical restraints on the recruitment of adults are much less stringent than on the recruitment of children.

The unpressurised method of recruiting pre-school children used in this study produced a group of highly motivated mothers with a genuine interest in the research, who tended to be friendly, outgoing, sociable and very willing to cooperate. Mothers with such a personality are not confined to any particular social class group and so children were recruited from across the social class spectrum, with an anticiptated slight bias towards social class I and II.

The degree of cooperation from mothers was unprecedented. Young children tend to eat small frequent snacks and leave many leftovers, as recorded by their mothers in scrupulous detail. The method of approach taken to mothers, for example providing clear and comprehensive instructions with neat reliable equipment, and taking time at the introductory visit to instil a sense of confidence and capability, undoubtedly encouraged this high degree of cooperation. Examples from the childrens' food diaries can be found in appendix 2. As most mothers were unfamiliar with weighing food in grams their recorded weights are a guide to the validity of the data, as mothers could not realistically estimate food quantities without weighing items. Brand names of foods and recipes were also given. Such detail was of equal quality from mothers of social class IV and V as from I and II. In many cases it was the child's father who completed the food diaries if the child's mother was working. One mother, though semi – literate and living in a condition of poverty, obtained considerable satisfaction and a sense of achievement from the completion of a detailed survey.

The raw dietary data was translated into food codes and weights with scrupulous attention to detail and a system of double checks at each stage of the procedure. Though extremely time-consuming the result of this concerted effort on the part of the investigator and mother is a highly accurate account of the diet of a large cohort of pre-school children. Whilst the study may be biased towards highly motivated mothers, the wide variation of diet survey results suggest that the data is not biased towards a 'favourable' type of diet, perhaps because mothers' attitudes to nutrition and their concepts of a 'healthy diet' are varied.

The combination of dietary, questionnaire and anthropometric data has produced such a vast quantity of information that SPSS PC+, though one of the most powerful statistical software package available for microcomputers, was unable to handle all the data at any one time. The main core of data relating diet to growth is presented in this thesis.

FACTORS INFLUENCING THE EATING HABITS OF PRE-SCHOOL CHILDREN.

Children are recommended to be weaned from a diet of liquid milk alone on to solid food at the age of 4 - 6 months. This transition in eating habits and of dietary composittion, from a milk diet (50% energy from fat) to solid foods (40% or less energy from fat), is a process that is believed by many to take up to five years to complete (Taitz 1987, Buttriss 1988).

An examination of the frequency of food intake of children aged 2 to 4 years (Table 11) found a pattern of food intake closely resembling that of family eating habits. This suggests that eating patterns are actually formed at a very early age, tending to stabilise during the pre-school years. Even at the age of two years the reported frequency of intake of the staple foods represented in Table 11 is very similar to that of the family. The most striking difference between the pre-school child and family eating habits is the high proportion (almost 20%) of children who are reported as 'never' eating vegetables, compared to only 2% of families. This is of concern as these children will almost certainly grow into adulthood with a very limited diet, lacking not only the texture and variety of tastes and colour provided by vegetables, but reduced in minerals, vitamins and dietary fibre. Interestingly, there is an increasing preference with age across the pre-school years for salad vegetables. Most children at least eat fresh fruit daily.

Table 11 however, is unable to show that despite a similar frequency of usage of staple foods, the composition of the diet of young children and adults is very different, as foods are eaten in quite different proportions (Tables 28 and 29). Two year old children were actually found to have a lower % of energy from fat (36%) than adults (40% ex. alcohol).

There are additional trends in consumption of specific types of food across the pre-school years. A perceived trend towards use of semi-skimmed milk by older children is not related to food preference but largely to the mother's interpretation of current health education messages relating to milk. 62% of mothers reported concern about nutrition (Table 12).

The table habits of this cohort of children give cause for concern as 10% of children rarely sit at a table to eat and many frequently watch television whilst eating (Table 13). The reality of mealtimes of these children is of little relevance to our traditional concept of meals and eating behaviour. Such children may therefore have difficulty in coping during mealtimes at nursery and school.

Table 14 examined children's nutrient intake and anthropometric parameters in relation to the mother's perception of her child's appetite. The results suggest that not only the quantity but quality of a childs diet is significantly affected by appetite. Thus a mother's perception of her child's appetite can be a useful tool in assessing the adequacy and quality of a child's diet. A high proportion of children, 46%, were in some respect described as poor eaters. This figure, however, corresponds with earlier studies in the USA and in Scotland which cite slightly over 40% of mothers of pre-school infants expressing concern that their child ate only a limited variety of foods, or ate slowly (Wright 1991).

The reported use of vitamin supplements was surprisingly low, given that many mothers simultaneously expressed an interest in nutrition and concern over their childrens eating habits (Table 15). Supplementation with vitamin drops is recommended for pre-school children (DHSS 1988). Many mothers were unaware of the availability of inexpensive vitamin drops from their local clinics. Many were also unaware of the wisdom of giving fluoride supplements. It would appear that there is a lack of communication between health visitors or G.P. s and mothers of the availability of, and need for, vitamin and fluoride supplements.

Of this cohort of children only 33% - 55% between 2 and 5 years are receiving fluoride and 7% do not clean their teeth daily. Of the children who do clean their teeth daily, 36% of 2 year olds and almost 50% of 4 year olds do so without the help of an adult. Thus even among the children of highly motivated mothers dental habits are far from ideal. This perhaps explains why we found a rapid increase in the incidence of dental caries between 3 and 4 years of age. Geddes (1991) suggests that 49% of 5 year old children are affected by dental caries. Young children certainly take a very high sugar intake (Table 20 and 21). This study found no evidence to suggest that the incidence of dental caries was related to the estimated sugar intake of children, though mothers did imply that they had reduced their children's sugar intake after the onset of dental disease (Table 17).

An additional cause for concern is the high incidence of food allergy reported among the children studied, particularly as 7 children were allergic to milk and/or eggs with symptoms of eczema, asthma or urticarial rash. These are difficult foods to avoid without up-to-date professional advice, and milk substitutes are essential for children. Unfortunately only 3 children had received adequate dietetic advice and only one appeared to follow a milk-free diet, though all had milk substitutes available. If these children are truly allergic to milk or eggs then partial avoidance will be of little benefit. If they are not intolerant of these foods then unsupervised dietary manipulation could cause deleterious dietary consequences for the child. There is clearly a need for G.P. s to take the subject of allergy seriously, to ensure adequate dietary advice for children and to monitor the outcome of treatment.

INTAKE OF ENERGY AND NUTRIENTS.

Measurement of energy intakes is of importance to this dietary survey as it is the yardstick by which the validity of data will be assessed (Prentice et al 1988, Livingston et al. 1990).

This study found total daily energy intake to be 20% - 25% lower than found in earlier dietary surveys of UK pre-school children, except for that of Black and Paul (1987) who also found the mean energy intake of a small cohort or 2 and 3 year old children to be 20% - 25% lower than previous surveys (Table 1).

Expressing the results of this present study as 'energy intake per kg body weight' (Kcal/kg) produces figures 24% - 30% lower, at 68 - 77 Kcal/kg for children aged 2 - 4 years, than found in previous UK studies (Table 1).

Recent non-UK dietary surveys of pre-school children give variable results for energy intake, but as none are based on the 7-day weighed intake method they are not directly comparable to this study (Table 2). Magarey and Boulton (1984), Hoffman et al. (1986) and Franscescato et al. (1990) report mean daily energy intakes that are intermediate between this study and previous UK dietary studies.

The energy intake of children in this study is therefore low compared to previous UK and non-UK dietary surveys, and is also 15% - 20% lower than the present EARs for energy of girls and boys age 2, 3 and 4 years

(Table 22). However, the current EARs of energy for pre-school children are based on a compromise between the estimated energy intake of previous dietary surveys and recent estimates of energy expenditure based on the doubly labelled water (DLW) technique (DOH 1991).

Though the actual energy expenditure of children in this survey is unknown, recent estimates of total daily energy expenditure (TDEE) in pre-school children using the DLW technique provide useful comparative data. Prentice et al. (1988) estimated TDEE in Cambridge children aged 24 - 36 months at 81 Kcal/kg, in comparison to a dietary intake of 77 Kcal/kg found in this present study. The same group of researchers report the mean TDEE of 13 three year old boys to be 1288 Kcal/day (84 Kcal/kg), and that of 18 three year old girls to be 1133 Kcal/day (77 Kcal/kg) (Davies et al. 1991). In comparison, this study found the mean energy intake of three year old boys to be 1191 Kcal/day (74 Kcal/kg) and that of three year old girls to be 1132 Kcal/day (73 kcal/kg).

The energy intakes per kg body weight of pre-school children in this study are slightly lower than those estimated by Prentice et al. (1988) and Davies et al. (1991) using the DLW technique. The difference may reflect a degree of experimental error in both methodologies, or could possibly reflect a regional difference in energy requirements. However, the results for 2 year old children and 3 year old girls fall within the margin of error of the DLW technique, as the experimental error is reported to be +/- 5%, (Jequier and Schutz, 1988). Furthermore, as present estimates of energy expenditure in pre-school children are based on a combination of data from very small groups of healthy UK children and data obtained from the measurement of energy expenditure in malnourished infants, they therefore do not necessarily reflect energy expenditure in the population of UK pre-school children (Fjeld and Schoeller 1988, Vasquez-Velasquez 1988, Prentice et al. 1988, DOH 1991). No values for energy expenditure are available for children aged 4 years.

As the results of this study compare well with recent estimates of energy expenditure in pre-school children they suggest that today's generation of children either have a lower energy requirement than previous generations, due perhaps to inactivity, or earlier studies over-estimated food intake. The truth may be a combination of these factors. Armstrong et al. (1990) reported a surprisingly low level of physical activity in UK children aged 11 - 16 years, boys being more active than girls. Pre-school children today certainly have a different lifestyle compared to children of 25 years ago, televisions, videos, cars and central heating possibly contributing to a lower energy requirement. Mothers also have greater fears of allowing children to play outdoors.

The possibility of greater inaccuracy in previous studies should also be addressed. Comparison of the results of this study with TDEE measured using the DLW technique gives credibility to the methodology used in this dietary survey, in respect of the ability of mothers to weigh and record foods accurately and in the interpretation of food weights into nutrients by the researcher. Highly accurate digital scales were found to be essential in this study as young children tend to nibble very small portions of food throughout the day, such as biscuits, cheese, fruit, and small sandwiches, leaving many left-overs. Earlier studies however, did not have access to highly accurate digital scales to weigh food, relying on spring balance scales such as those used by Widdowson (1947) with a minimum calibration of 0.25 ounces (7g), thus a high degree of error. It is questionable whether such scales could accurately assess the small portions of food consumed by young children. Additionally, as the method of approach to mothers in previous studies may have been more persuasive it is possible that mothers were less motivated by a genuine desire to participate in the research and thus more inclined to inaccuracy.

Whilst estimates of total energy intake are of interest, as they provide a means of validating dietary data, it is also of interest to examine sources of energy in the diet.

Little variation was found between children of ages 2, 3 and 4 years in sources of energy intake (Table 23).

The group mean % of energy derived from sugar was found to be high, at 29% - 31%, but similar to the reported intake of 4 year old Australian girls and boys, taking 28% and 29% of energy from sugar respectively (Magarey and Boulton 1984). Refined sugar in Ribena, squash, chocolate, sweets and jam contributed over 40% of sugar in children with a high sugar intake (Table 24). Natural sugars from pure fruit juice, fresh fruit and milk products contributes over 30% of sugar intake. Pre-school children eat very little table sugar, contributing only 1% of the sugar intake of children on a high sugar diet (Table 24).

It is popularly assumed that British pre-school children have a high fat intake, derived mainly from dairy products, hence caution is expressed in advising children to reduce fat intake to 35% of energy from fat as it is feared they may be unable to maintain their energy intake (COMA 1984, Taitz 1987, DHSS 1988, Lloyd 1991). The evidence from this study suggests that this fear is unfounded. The % of energy derived from fat by pre-school children in this study, at mean group levels of 34% - 36% of energy (Table 23), is much lower than the % of energy derived from fat in previous studies, at 37% - 40% of energy from fat (Table 1). Total daily energy intake by children in this study is certainly lower than that recorded in previous studies, but as children in this study are growing adequately (Table 38) there is no evidence to suggest that children today receive an in-adequate energy intake.

Comparing the % of energy from fat of children in this study to recent non-UK studies it can be seen that the figures from Sweden, Australia and the Netherlands are very similiar (Table 2). It is possible that these figures reflect a heightened global awareness of nutrition education that it is beginning to affect the type of diet people choose to feed their children.

Although the % of energy from total fat intake is relatively low, the % of energy derived from saturated fat is quite high, at levels in excess of 15% - 16% at 2 years (Table 23). This is because young children derive a large proportion of their fat from full-fat milk (Table 24), contributing to a low P:S ratio of 0.2 - 0.3.

It is pertinent to note that whilst the total fat intake of young children is relatively low at 34% - 36% of energy, the fat intake of older children and adults is relatively high at 38% - 40% of non-alcohol energy (Tables 28, 29). Similar high levels of fat intake were found in two very recent studies of children aged 11 - 12 years (Nelson 1991, McNeill et al. 1991).

A correlation coefficient of -0.63 (P<0.001) exists between the % of energy from sugar and % of energy from fat in this study (Table 32). Thus, independent of total energy intake, fat intake (mean 34% - 36% of energy) is inversely related to sugar intake (mean 29% - 30% of energy). Both Nelson (1991) and McNeill et al. (1991) found the intake of sugar of 11 - 12 year old children to be 21% of energy. The sugar intake of Scottish adults is

16% - 18% of energy. This suggests that the problem facing health educators is not one of safely reducing children's fat intake to levels of 35% of energy from fat by five years of age, but of preventing children's fat intake rising above 35% of energy whilst sugar intake actually declines during the primary school years. To achieve this aim, a higher intake of starchy foods is required.

The starch intake of pre-school children in this study ranged from 9% - 34% of energy with a mean intake of 19% - 21% of energy in girls, and 21% - 23% of energy in boys (Table 33). As there is no significant correlation of energy intake with % of energy from starch (r = -.07), it appears that pre-school children are quite able to maintain energy intake on diets providing a higher % of energy from starch (Table 30). Furthermore, Table 35 suggests that the eating habits of children are formed at a very early age, as early as 2 years, with dietary patterns tending to 'track' during the remaining pre-school year. This is particularly true of starch intake, with a correlation coefficient of 0.77 (P<0.001) for starch intake (g) from the initial 7-day survey with starch intake (g) from the repeat survey. A high correlation of 0.69 (P<0.001) has also been obtained for the % of energy from starch from the initial survey with the repeat survey. This suggests that it would be beneficial to encourage children to take a high starch intake from an early age as a high intake is then more likely to be maintained into the school years. This would help to reduce sugar intake during the pre-school years and help to prevent fat intake rising in later childhood.

Sugar and starch intake are not differentiated from total carbohydrate in 'The Diet of British Schoolchildren', a recently published study of the diet of 10 - 15 year old children (Tables 28, 29)(DOH 1989b). However, Nelson (1991) and McNeill et al. (1991) found the starch intake of 11 - 12 year old schoolchildren to be 28% - 29% of energy, suggesting that starch intake does rise during the school years, but is seen to fall again in adulthood as alcohol intake rises (Tables 28, 29).

There is a strong correlation between % of energy from starch in the diet and intake of fibre (g/1000 kcal) of 0.50 (P<0.001) (Table 33). Intake of fibre has been found to vary considerably, from 4g to 17g per day (Tables 20 and 21). No previous information on the fibre intake of UK pre-school children is available.

Burkitt et al. (1980) encouraged both children and adults to take a high fibre diet to prevent constipation. Many others discourage an excess of fibre in the diet of young children as it is thought to increase the bulk of the diet, reducing energy intake, and may also reduce the absorption of minerals (Saunders 1981, BDA 1987).

Despite a four-fold difference in the fibre intake of children in this study, no significant relationship has been found between intake of fibre and bowel habits.

Mothers reported that 72% of children pass a stool once daily and 18% more often (Table 18).

Looking at energy intake in relation to fibre intake, Table 46 compares the energy intake of 17 children on a low fibre diet (mean intake 5.3 g fibre) to the energy intake of 17 children on a high fibre diet (mean intake 14.9 g fibre). The energy intake of children on a high fibre diet was significantly higher than those on a low fibre diet (P<001), although this may be partly related to an age difference of 11 months between the mean ages of the two groups. In addition, a significant positive correlation has been found between fibre intake and energy intake, of 0.49 (P<0.001) (Table 31). This does not suggest that fibre promotes energy intake, but rather that fibre is widely distributed in the foods young children eat. Thus children with a high energy intake more readily increased their intake of fibre. There is therefore no evidence from this study to suggest that a high fibre intake reduced energy intake, rather, that children with higher energy intakes tended to have higher fibre intakes.

Assessing the influence of fibre and associated phytic acid on the absorption of minerals was beyond the scope of this study. In reviewing the availability of iron from infant foods, Cook and Bothwell (1984) concluded that there is little direct evidence that fibre per se inhibits the absorption of non-haem iron in humans. The inhibitory effect of phytic acid on the absorption of minerals is less clear. This is a matter of concern as over 40% of the fibre of children taking a high fibre diet is derived from cereals (Table 24). Recent consensus, however, is of the opinion that most diets in western countries do not contain enough phytic acid to predispose individuals to mineral deficiencies (Bindra 1985, BDA 1987).

The dietary iron intake of 2 year old children was low at 20% - 25% below the RNI, and in all groups of children minimum intakes were as low as LRNI values (Table 22). Thus, a minority of children, particularly the youngest, are at risk of iron deficiency anaemia. This condition is recognised, even in Britain today, as a major health problem which can lead to psychomotor delay (James et al. 1989).

The main sources of iron in this study were fortified breakfast cereals, wholemeal bread, brown bread, and meat products, so non-haem iron is the predominant type of iron in the diet of young children. This is also true of western diets in general which provide 85% - 90% of iron in the non-haem form (Rossander 1979). As children today tend to eat very small amounts of red meat its contribution to total iron intake is exceptionally low. Foods with a low iron content, such as fish fingers, cheese and chicken, are perhaps more popular now as substitutes for meat than they were twenty years ago.

As fortified breakfast cereals are a major source of iron in the diet of young children, the bioavailibility of non-haem iron is a matter of concern. In the past, iron compounds used to fortify foods, such as ferric orthophosphate and ferric pyrophosphate, were poorly absorbed due to their large particle size and surface area (Cook and Bothwell 1984). Alternative iron compounds such as ferrous sulphate, which is well absorbed, are now more commonly used to fortify infant foods and cereals (Cook and Bothwell 1984). Other main factors determining iron absorption are iron status, the total iron content of food and the composition of a meal. Rossander (1979) measured the absorption of iron from breakfast meals in 129 men and women. Non-anaemic subjects absorbed on average 7.6% of non-haem iron from a reference meal of rolls made with fortified white flour. If the meal included tea, iron absorption was reduced by 50%, drinking chocolate also reduced iron absorption by 25%. Pure orange juice, with a high vitamin C content had the effect of increasing iron absorption by over 100%. Encouraging young children to take a vitamin C rich drink at breakfast time could therefore greatly help to enhance dietary iron absorption.

Encouraging young children to drink vitamin C rich pure fruit juice and Ribena is, however, a matter to be viewed with caution. Whilst these drinks increase vitamin C intake and enhance the absorption of iron they are both extremely high in sugar and very acidic, factors that contribute to tooth decay (Geddes 1991). Children in this study do have a high sugar intake of, on average, 30% of energy intake (Table 23). On examining sources of sugar in the diet of 10 children with a high sugar intake of 40% - 53% of energy from sugar, it is apparent that Ribena and pure fruit juice together contribute 38% of sugar intake (Table 24). Due to their high vitamin C content and 'natural' image both drinks are regarded by parents as 'healthy'. It is important that health professionals attempt to impart to parents that whilst a little fruit juice may be 'healthy', (especially taken with breakfast cereals), more is not necessarily 'healthier'.

The mean and median intakes of vitamin D are exceptionally low, yet none of the children in this study had clinical symptoms of rickets. The vitamin D intake of this group of children is similar to that measured by Poskitt et al. (1979) in a study of 110 girls and boys aged 4 - 6 years. Poskitt assessed girls intake at 1.0 mcg/day and boys at 1.7 mcg/day. In comparison, 4 year old girls and boys in this study had mean intakes of 1.5 mcg and 1.4 mcg respectively. Poskitt et al. measured serum 25-hydroxy vitamin D (25-OHD) levels in the children, finding a pronounced seasonal variation with levels highest in August and lowest in February. There were no clinical or biochemical signs of rickets. It was concluded that even in winter serum 25-OHD levels are determined more by previous exposure to summer sunlight than by dietary intake of vitamin D.

As nutrient intake varies considerably within our cohort of pre-school children it is pertinent to look at variation with socioeconomic group, classified according to fathers' occupations (Tables 26, 27).

It is perhaps surprising that there are no significant socioeconomic differences in nutrient intake for either girls or boys (except a weak positive correlation with MUFA in boys), as former studies of UK pre-school children have all found a significant inverse relationships between energy intake and socioeconomic group, i.e. children from higher socioeconomic groups had a lower energy intake, (Widdowson 1947, Bransby and Fothergill 1954, Black et al. 1976, DHSS 1975). The similarity of energy intake across the socioeconomic groups is possibly a reflection of a more sedentary lifestyle led by all groups of children. Similarities in nutrient intake may also perhaps be related to the high intake and popularity of certain convenience foods, such as tinned spaghetti, baked beans, fish fingers, sausages, cheese, pizzas, yoghurts, oven chips, crisps, fruit juice, squash and ribena, by children across the socioeconomic spectrum.

It is interesting to compare nutrient intake by socioeconomic group with the recent national dietary survey of British adults (OPCS 1990).

Adult women in social class I and II and men in group III-non-manual had significantly higher energy intakes; similar trends are not apparent in children in this study. However, there are similarities in trends in the intake of fat, sugar and fibre.

In both men and women the percentage of energy derived from fat was not significantly related to social class, as found in this study. However, men in socioeconomic groups IV and V had significantly lower P:S ratios in their diets. For pre-school boys, but not girls, there is a tendency towards lower P:S ratios in the manual socioeconomic groups.

In men, sugar intake was significantly lower in the manual social classes, and tended to be higher in social class I and II in women. In pre-school boys and girls there is a non-significant tendency towards lower sugar intakes in socioeconomic group IV and V.

The fibre intake of both men and women was significantly higher in social classes I and II. A similar, though non-significant trend is apparent for pre-school girls and boys.

Therefore, although there are no statistically significant differences in nutrient intake by pre-school children across the socioeconomic groups, trends are emerging which suggest that characteristic differences in the nutrient intake of socioeconomic groups are in the process of forming.

THE EFFECT OF VARIATION IN DIETARY COMPOSITION ON ENERGY AND NUTRIENT INTAKE, AND ANALYSIS OF THE RELATIONSHIP BETWEEN INTAKE OF NUTRIENTS.

On studying the diet of groups of people or individuals, intake of individual nutrients cannot be examined entirely in isolation from each other. The previous discussion examined the relationship between sugar and fat intake and briefly alluded to the relationships between starch and fibre intake, and fibre and energy intake.

The relationship between variation in dietary composition and intake of energy is extremely interesting (Table 30). No significant correlation was found for the correlation of energy intake with % of energy from fat, protein, sugar and starch, implying that young children are able to adapt to variations in the energy density of their diet, so precisely regulating energy intake to energy expenditure. This supports earlier research by Davis (1938) who concluded 'the existance of some innate, automatic mechanism...that regulates appetite'. The early studies of Davis allowed children to self-select from a healthy choice of foods. Her research has recently been reviewed and the conclusions questioned by Storey and Brown (1987). They believe that the mechanism regulating appetite, energy intake and body weight is operative only for the "primitive diet" of Davis, based on unprocessed foods with no added sugar, and suggest that free access to high-calorie, low-nutrient foods may encourage the development of obesity in childhood. This present study of pre-school children does not support this view of Storey and Brown (1987) as the diet of children in this study included a wide range of palatable high energy convenience foods, yet composition of the diet did not affect total energy intake (Table 30). Furthermore, no significant correlation has been found between % of energy from sugar, fat, or protein and body weight, or weight for age (Table 43). Only a weak but significant correlation has been found for the % of energy from starch with body weight (P<0.01) (Table 43).

Recent research by Birch et al. (1991) sought to measure the variability of young childrens' energy intake. The food intake of fifteen pre-school children aged 2 to 5 years was studied over a period of six days. The childrens' food intake at individual meals was highly variable, but total daily energy intake was relatively constant for each child, with a mean within person coefficient of variation of 10.4%. The paper of Birch et al. therefore supports the views of Davis (1938), and the implication of this study, that pre-school children have an innate ability to control energy intake.

Though a child's energy intake appears to be under close physiological control, there is much variation in energy intake between children (Table 22). This variation in energy intake, and thus requirement, is found to account for much of the variation in the intake of macronutrients, minerals and vitamins (Table 31). If energy is the independent variable and other nutrients dependent variables, the degree of association is indicated by the correlation coefficient. Fat intake (g/day) is highly correlated with energy intake at 0.82, as is protein intake (g) at 0.78, and sugar and starch intake (g) at 0.61 and 0.63 respectively, ($P<0.001$). A significant relationship between the intake of energy and other nutrients was also noted in The Dietary and Nutritional Survey of British Adults, which found correlation coefficients of 0.87 and 0.91 respectfully, for men and women for the intake of energy with fat (g).

In recent years, dietary guidelines for adults have often advocated a reduction in both the sugar and fat components of the diet (DHSS 1978, NACNE 1983, DOH 1991). Table 32 correlates intake of nutrients with each other, expressed as a % of energy to avoid bias due to variation in energy intake. A strong negative relationship is found between the intake of fat and sugar of -0.63 ($P<0.001$). There are highly significant but weaker relationships between the intake of fat and starch, and sugar and starch, at -0.32 and -0.46 respectively ($P<0.001$) (Table 32). This implies that it could be difficult to reduce the % of energy derived from fat without effecting a corresponding rise in % of energy from sugar, and vice versa, as an increase in starch intake to compensate energy intake is less easily achieved. It is clearly only practical to aim to achieve very small simultaneous reductions in the diet of sugar and fat. To formulate realistic dietary guideline it is therefore essential to take account of the strong relationship between intake of sugar and fat.

This relationship between fat and sugar intake is rarely alluded to in reviews and research investigating people's ability to follow dietary guidelines (Church 1986, Cole-Hamilton et al. 1986, BDA 1987, Warwick and Williams 1987, Bradley and Theobold 1988, Hackett 1990). For example, review publications such as 'Childrens Diet and Change' (BDA 1987), have independently discussed the role of sugar and fat in the diet, with no regard to their relationship with each other. Furthermore, poorly conducted research such as that of Hackett et al. (1990), which draws judgement from self-completed questionnaires of people's eating habits without examining actual nutrient intake, serves only to strengthen preconceived and perhaps biased ideas. Experience from the analysis of diets in this survey suggests that such methodology is very unwise as categorising foods as 'favourable' and 'unfavourable' is very subjective.

The issue is further complicated by confusion in the use of the term 'sugar', both in the definition of dietary guidelines and in the results of dietary analyses (Cole-Hamilton et al. 1986, Bradley and Theobold 1988, Cade and Booth 1990). Whilst the NACNE report (1983) advised a reduction in 'sucrose' intake, (thus excepting natural sugars in fruit and fruit juices), the 1984 COMA report 'Diet and Cardiovascular Disease' advised 'no increase' in simple sugars, (including fructose, and thus natural sugars in fruit and fruit juice). Unfortunately 'sugar' is often poorly defined in publications (Levy 1990). In this study of pre-school children 'sugar' or 'total sugar' refers to all mono- and disaccharides present in food; this includes lactose and naturally occurring sugars in fruit and fruit juices. 'Added sugar' refers to packet sugar used in the home, and all mono- and di-saccharides added in food preparation. 'Sucrose' is sucrose.

Even when the term 'sugar' is clearly defined the effect of dietary variation on 'total sugar' intake may be uncertain, and comparison between studies is difficult. Black et al. (1984), for an assessment of the practicality of NACNE (1983) dietary goals, examined only the sucrose component of the diet giving no figures for 'total sugar', before or after dietary intervention. Whilst a desirable reduction in sucrose intake was observed, intake of fruit and fruit juice increased. Thus it is possible that 'total sugar' intake was unchanged. Nelson (1985) with a similar aim to Black, in relation to both the NACNE (1983) and COMA (1984) reports, chose to study the 'total sugar' content of the diet, whilst Bradley and Theobold (1988) examined the effect of dietary modification on 'added sugar' alone.

As exemplified by the NACNE report (1983) and COMA report (1984), attitudes to natural sugars in fruit and fruit juices vary. They may be regarded as favourable, preferable to refined sugars, warranting inclusion with complex carbohydrate in dietary analysis, or may be regarded simply as 'sugar', another component of 'total sugar'. It is pertinent to reflect that children in this study who drank a great deal of pure fruit juice had very high intakes of 'total sugar' (Table 24), and also high intakes of fruit acid, which is extremely corrosive to teeth (Geddes 1991).

Gibney (1990b) drew attention to the apparent incompatibility of recommending a reduction in intake of both fat and sugar in the diet. However, it is hardly surprising that little attention has been paid to the reciprocal relationship between % of energy from total sugar and fat in the diet as it is extremely difficult to elucidate this information from currently available literature, there being much confusion in the definition of 'sugar' and in its relationship to dietary guidelines.

Whilst variation in the intake of macronutrients, expressed as % of energy, did not affect total energy intake (Table 30), there were highly significant relationships with the intake of fibre, minerals and vitamins expressed as wt./1000 kcal (Table 33). Hence variation in the intake of fat, sugar, starch and protein affects the quality of the diet, in terms of concentration of micronutrient intake.

Both fat and sugar have significant negative associations with intake of vitamin B1 and niacin

(P<0.001), and vitamin B6 (P<0.01), whilst intake of starch is positively correlated to intake of these vitamins (P<0.001). Intake of fat is negatively associated with intake of fibre and iron (P<0.001), whilst starch intake is positively associated with these nutrients (P<0.001). There is no significant correlation of vitamin D or zinc intake with fat and starch intake, but both are negatively correlated with intake of sugar. An improvement in the intake of vitamin B1, niacin, vitamin B6, vitamin D, fibre, iron and zinc would therefore be the most significant immediate benefits of encouraging a mild reduction in the intake of fat and sugar in the diet of pre-school children and an increase in the intake of starch. As the correlation of starch intake with iron intake is high at 0.43 (P<0.01), an improvement in the intake of starchy foods, particularly iron fortified cereals, would benefit those children who currently have an exceptionally low intake of iron. Although fat intake is positively associated with intake of vitamin A and calcium, and starch intake negatively associated with intake of these nutrients, adequate intake of vitamin A and calcium could be maintained by encouraging the use of semi-skimmed milk rather than full-fat milk (Table 50).

Protein intake is positively associated with intake of calcium and B group vitamins. However, as the protein intake of each group of children is adequate (Table 22), and protein rich foods tend to be expensive to purchase, it would be unrealistic to advocate an increase in the intake of protein rich foods. Interestingly, protein intake is not correlated with iron intake, which highlights the low contribution of red meat to the total iron and protein intake of pre-school children.

It may be queried why it is necessary to discern means of improving the diet of pre-school children when group mean values for the intake of mineral and vitamin are deemed adequate in relation to RNI values, with the exception of iron and vitamin D. Immediate benefits are suggested by Table 34, which correlates the intake of fibre, vitamins and minerals per 1000 kcal with each other. There are many strong positive correlations between intake of nutrients. For example, the correlation coefficients for intake of iron with fibre, vitamin B1, niacin, and vitamin B6 are 0.61, 0.62, 0.52 , and 0.46 respectively ($P<0.001$). The correlation coefficient for intake of vitamin B1 with vitamin B2, niacin, vitamin B6, vitamin D and vitamin C are 0.51, 0.47, 0.53, 0.31 and 0.25 respectively ($P<0.001$). Zinc intake is positively correlated with intake of vitamin B1, vitamin B2, niacin, vitamin B6 vitamin B12, and vitamin A, at 0.51, 0.39, 0.20, 0.22, 0.26 and 0.32 respectively ($P<0.001$). Although a few negative nutrient correlations are apparent, for example -0.28 between calcium and iron, the majority of associations are positive and highly significant. There is therefore a strong tendency for children who have a low intake of one nutrient, per 1000 kcal, to have a low intake of a range of associated nutrients. Thus a minority of children have particularly poor quality diets, with low intakes of a wide range of nutrients. This is alarming as within each group of children the actual intake of specific nutrients ranged widely, with a minority of children barely attaining the LRNI values of vitamins. It is children with generalised low intakes of vitamins and minerals who will most readiliy benefit from simple and practical advice on means of improving the quality of the diet. An added benefit to promoting a mild reduction in fat and sugar intake and encouraging a higher starch intake is that these changes are in line with advice given to older children and adults towards reducing the risk of future cardiovascular disease (NACNE 1983, DHSS (COMA) 1984, DOH 1991). Recent dietary guidelines issued by the Department of Health reinforces earlier advice to adults to reduce sugar and fat intake in the diet. Whether these guidelines are intended to be applied to young children is uncertain due to ambiguity in the document (DOH 1991). The results of this survey of pre-school children, however, suggest that the basic principles of advice to adults should be applied to the preschool years, not only to help reduce the incidence of future degenerative diseases such as heart disease and cancer, but to help improve the quality of the diet itself.

This view is strengthened by Table 35, correlating average daily intake of nutrients during the initial survey with intake during the repeat survey. This shows a highly significant tendency for the intake of nutrients to track during the pre-school years, especially starch ($r = 0.77$), but also iron ($r = 0.62$), calcium ($r = 0.58$), vitamin B1 ($r = 0.53$), vitamin B2 ($r = 0.60$), niacin ($r = 0.46$), vitamin B12 ($r = 0.63$) and others ($P<0.001$). Therefore, not only has a group of children with a poor quality diet and a low intake of a range of vitamins and minerals been identified, but it is apparent that this state has a tendency to persist during the pre-school years, and possible into later childhood. Of relevance to this issue is a tendency for energy intake to track during the pre-school years, with a correlation coef-ficent of 0.57 ($P<0.001$). As energy intake has a sig-nificant positive correlation with intake of most nutrients (Table 21), children with a tendency to low energy intakes are at risk of a low intake of vitamins and minerals which may be compounded by a poor quality of diet. There is therefore good reason to encourage children, who are assessed as having a low energy intake to increase their intake of starchy foods and marginally reduce intake of fat and sugar, as this improves the quality of their diet.

COMPARISON OF PARAMETERS OF GROWTH IN PRE-SCHOOL CHILDREN TO UK STANDARDS OF GROWTH.

Despite considerable variation in the nutrient intake of children in this study, results of the anthropometric assessement suggest that children are growing well. When parameters are distributed on age-related centile charts no child falls beneath the 3rd percentile for any measurement. However, for each parameter, within each group of children, results are plotted across the full range of normality (Tables 36 and 37).

Group mean values for weight in girls and boys are close to the 50th percentile values, suggesting that the weight for age of pre-school children has changed little since the centile charts were prepared from measurements of children taken during 1959 (Tanner et al. 1966). Group mean values for height however, are well above the 50th percentile, ranging from 57 for 2 year old girls to 67 for 2 year old boys. Therefore, children from Edinburgh today tend to be taller than were the children from London, when the current UK standard charts were prepared in 1959 (Tanner et al. 1966).

Some of the pre-school children in this study are quite 'sturdy' with weight for height percentiles above 90, and skinfold thickness measurements as high as the 93rd percentile. Although perhaps overweight, none of the children gave the impression of being obese. Griffiths et al. (1985) discussed the difficulties of defining childhood obesity. Children of the same weight for height may have very different body compositions. Some may be heavy but not fat, others heavy and fat, and yet others fat but not heavy. Poskitt (1986) gave mean values for aspects of body weight of children age 1 - 6 years attending obesity clinics in Liverpool. Lean body mass for age, mid-arm circumference and body fat as a % of body weight were all high, showing that obese children do not deposit fat at the expense of lean tissue, but as well as lean. They therefore tend to exhibit accelerated growth of both lean and fat tissue.

As for measurements of height and weight, measurements of triceps skinfold thickness and subscapular skinfold thickness are distributed widely across the standard curves (Tables 36 and 37). Unlike the parameters of height and weight, group mean values for skinfold thicknesses generally fall well below the 50th percentile, especially for 2 year old children who have mean values on the 30th - 35th percentiles. Group mean values of children in this study do however compare very well with the 50th percentile values of Australian children studied by Boulton (1981). When the current UK standards were published by Tanner and Whitehouse (1975) it was stated that 'all centiles are above those given in the earlier standards published in 1962, and particularly so in infancy'. The infant data was based on figures from the Midland Infant Welfare Clinic, 1966 - 1967. This suggests that the infants used for updating the standard charts may have been drawn from a pool of children with a tendancy to 'plumpness', perhaps related to the feeding practices of the day, such as early weaning. The large differences observed between the current UK standards and values from this study of pre-school children, supported by the values of Boulton (1981), highlight a need for more frequent updating of the standard charts and also for, if possible, standards based on children drawn from a wider geographical area to avoid regional bias.

A high correlation coefficient of 0.97 for height, and 0.94 for height percentile taken during the initial survey with measurements taken one year later, confirms that children have a strong tendency to follow a pattern of growth in parallel to the current standard charts for height (Table 39). The emergence of such high correlation coefficents is also supportive of a high degree of accuracy of measurement of height. Highly significant but lower correlation coefficents for other anthropometric measurements in comparison to height is possibly due to greater annual fluctuation of measurement between children.

Comparison of the nutrient intake of children, grouped according to the socioeconomic status of fathers, found little significant difference between groups (Tables 26 and 27). Similarly, comparison of the mean anthropometric measurements of children, grouped by socioeconomic status of the fathers, found no significant differences among the boys and only a significant negative association of weight with lower socioeconomic group in girls ($P<0.01$). This marked tendency for girls from socioeconomic groups IV and V to be light is interesting as height is clearly maintained, suggesting as does Table 16, that these children are not malnourished.

The relationship between socioeconomic status and anthropometric measurements has varied in previous UK studies of pre-school children. DHSS (1975) found no significant difference in height or weight between the social classes, though children of socioeconomic groups IV and V tended to have a higher energy intake. Black et al. (1976) reported a similar result in pre-school children in relation to weight only; (no information on height is available). Widdowson (1947) found children of unemployed fathers to be below average in both weight and height.

It is well documented that children from 'manual' social groups in industrialised countries tend to be shorter than children from non-manual social groups (Tanner 1989). A recent study of 8491 British children aged 5 - 11 years verified this phenomenon but found the associaton not significant after allowing for biological variables such as parental height and birth weight (Guilliford et al. 1991). This study found no significant difference in parental heights with social group, which partly accounts for the similarity of height of children from different social groups in this study (Table 41). The relatively small sample size of this study may also have contributed to this finding.

ASSESSMENT OF THE INFLUENCE OF VARIATION IN DIETARY COMPOSITION ON GROWTH.

Chronic malnutrition and acute malnutrition delay growth, as illustrated by studies of the effects of famine associated with war and of children living in third world countries (Tanner 1989). Nutritional surveillance of large, or remote, populations tends to rely on an assessment of attained growth by anthropometric measurement, rather than on studies of food intake. In such surveys stunting of height in children, due to chronic malnutrition, is defined as a low height for age. Wasting, due to acute malnutrition, is defined as a low weight for height (Smith and Booth 1989). Threshold values for the classification of individuals as malnourished are established in relation to standard reference populations. Standard deviation scores, i.e. 'Z scores' are frequently used as parameters of comparison, with a value of -2 taken as the lower threshold. This methodology, relying on anthropometric criteria, does incur a risk of misclassifying individuals as malnourished who are adequately nourished, and vice versa. However, more extreme definitions of malnutrition are avoided to reduce the incidence of false negative classifications (Smith and Booth 1989).

The effects of mild to moderate malnutrition and of overnutrition on growth are less well documented. Comparison of results between studies is extremely difficult as methodology varies considerably. Studies may rely on anthropometry alone, with no dietary information; be based on a single anthropometric survey with unreliable dietary assessment based on recall; may assess growth in terms of 'weight' only, with no reference to height; and are usually cross-sectional rather than longitudinal. Such studies therefore have a tendency to draw conclusions on the relationship between nutrition and growth with information on attained growth only, without height velocity data and often with inadequate nutritional data (Forbes 1977, Black et al. 1976, DHSS 1975, Sigman et al. 1989, Gibson et al. 1991). Relationships between nutrition and growth are frequently perpetuated in research discussions, despite a lack of information with which to substantiate the conclusions drawn. For example, a significant relationship is often noted between energy intake and height or weight, without reference to growth velocity. Black et al. (1975) found a correlation of 0.25 for energy intake with weight ($P<0.05$); Sigman et al. (1989) found a correlation of 0.25 for energy intake with weight and of 0.32 for energy intake with height ($P<0.05$); Birch et al. (1991) found a correlation of 0.76 between daily energy intake and body weight. Such relationships tend to be interpreted as implying that high energy intakes promote growth and conversely, that small children are undernourished (Sigman et al. 1989, Gibson et al. 1991). In this study of pre-school children from Edinburgh, significant correlations of 0.48 and 0.53 ($P<0.001$) were also found for energy intake with height and energy intake with weight, respectively (Table 42a).

However, as there is no correlation of height velocity with energy intake (Table 44), we conclude that a significant relationship between height or weight and energy intake is not related to a growth promoting effect of high energy intakes but to a greater basal energy requirement of larger body masses and a greater energy expenditure in physical activity. In relation to weight gain, Paul et al. (1990) reached a similar conclusion from a study of children aged up to 3 years. At 3 years Paul et al. found no significant correlation between energy intake and weight gain; however, some of the variation in energy intake could be attributed to weight differences as a correlation of 0.63 ($P<0.001$) was found between body weight and total energy intake.

A second example of poorly substantiated conclusions on the relationship between nutrition and growth is in attributing the observed association between obesity and height velocity in childhood to unclarified 'overnutrition' (Forbes 1977, Brook and Abernethy 1985, Forbes 1991). Forbes (1977) longitudinally studied the growth patterns of 18 obese children, though did not actually measure energy intake, and concluded 'the relative food excess that is necessary to initiate the obese state is in reality a form of overnutrition. The growth rate of a child is thus responsive, both in a positive and a negative direction, to the level of nutrient intake'. On the basis of this early work Forbes (1991) states 'growth requires energy, and it is known that underfed children have subnormal growth rates and that overfed children grow faster than normal. Thus, growth rate serves as an excellent bioassay for nutrient intake.' This over-simplistic view of the relationship between nutrition and growth is of concern, as it is in this manner that insubstantiated conclusions of research relating diet to growth are perpetuated. Definition of 'overnutrition' as it relates to the positive energy balance of obese children, is not necessarily the same as that relating to an excess intake of food by non-obese children. In obese children weight gain arises due to energy imbalance, the cause of which is not fully known, although its complex aetiology does include a genetic component and is related to alterations in RMR/kg body weight (Poskitt 1986, Griffiths et al. 1990). Observations on the energetics of obese children therefore cannot be extrapolated to the child population at large. In a longitudinal study of metabolic rate and physical development in childhood, Griffiths et al. (1990) found distinctive metabolic differences between boys and girls of obese parents. Sons of obese parents tended to have a lower energy intake during childhood and a lower energy expenditure in adolescence and yet grew more rapidly than sons of normal weight parents. In contrast, girls of obese parents did not differ in energy expenditure or growth rate from girls of non-obese parents. However in girls, childhood energy intake was correlated to body mass and adiposity in adolescence. It is hypothesised that in childhood the pre-obese have a faster rate of growth and development and of decline in RMR/kg, leading to earlier adolescence. The process is more advanced in girls than in boys. It is postulated that low RMRs/kg are a feature of a precocious pattern of growth and are a risk factor for obesity (Griffiths et al. 1990). Therefore, whilst there is a relationship between a genetic tendency towards obesity and rapid growth in childhood, particularly in boys, there is no simple direct relationship between nutrient intake and adiposity or height velocity. The results of this survey of pre-school children lend support to the hypothesis of Griffiths et al. (1990), as no significant correlation of 'weight for height' percentile with energy intake was found, nor is there a significant correlation of energy intake with height velocity data (Table 44).

Tables 43 and 44 are central to our understanding of the relationship between nutrient intake and growth in this cohort of pre-school children from Edinburgh. Apart from the observation that variation in energy intake did not affect growth, it can also be seen that variation in sources of energy in the diet did not affect attained growth (Table 43) or height velocity (Table 44). This is almost certainly due to the ability of young children to maintain energy intake, irrespective of the composition of their diet, at least, within the normal boundaries of a Western style diet (Table 30). This finding is extremely important as it suggests that modification of diet in childhood, aimed at reducing morbidity and mortality in adulthood, will not have a detremental effect on growth. This conclusion widens the sphere of choice in the selection of an appropriate diet for children.

No relationship was found between intake of minerals and vitamins and growth velocity (Table 44). This is also a highly significant finding as it implies that although some children had low intakes of vitamin and minerals in relation to Dietary Reference Values (DOH 1991), for the individual children concerned, nutrient intakes were adequate to sustain growth. However, adequacy of nutrient intake to sustain growth cannot be extrapolated to imply an adequate intake for all physiological functions.

In 1988 a controversial debate on the effect of marginal intakes of vitamin and minerals on intelligence in schoolchildren was initiated (Benton and Roberts 1988). In a controlled study, Benton and Roberts supplemented the diet of a group of schoolchildren with a vitamin and mineral supplement and concluded a significant improvement in non-verbal intelligence in the supplemented group. The methodology of this survey aroused severe criticism and attempts were made by nutritionists to replicate the findings (Emery et al. 1988, Naismith et al. 1988). Two such studies undertaken in Dundee and London failed to support the original findings of Benton and Roberts (Nelson et al. 1990, Crombie et al. 1990). A more recent USA study by Schoenthaler et al. (1991) caught widespread media attention, claiming that a vitamin supplement dose of 100% RDA levels (of the USA) significantly improved the intelligence of schoolchildren, but doses of 50% or 200% RDA values were ineffective. The methodology of this study has also been criticised, as inadequate information on the initial nutritional status of the subjects was provided, and despite such a far reaching claim for a benefit of vitamin supplements, there is no explanation of the mechanism of the effect (Furnham 1991, Whitehead 1991). The effect of mineral and vitamin intake on the intellectual performance of schoolchildren will undoubtedly remain a controversial issue for some time. Should the outcome of this debate support a higher intake of minerals and vitamins, widespread promotion of supplements for schoolchildren is unlikely to be a sensible solution. An improvement in the nutritional quality of the diet of 'at risk' children would be a less hazardous long-term procedure.

Improvements in the quality of the diet of pre-school children, in terms of mineral and vitamin intake can be achieved by reducing the % of energy from fat and increasing the starch content of the diet, whilst ensuring an adequate intake of calcium and vitamin A (Table 33). Modifications to the diet of this nature are also in line with recommendations for older children and adults to help reduce the risk of future cardiovascular disease (NACNE 1983, DHSS (COMA) 1984, DOH 1991). Tables 43 and 44 suggest that such dietary modifications do not impair growth in pre-school children. To illustrate this finding

Tables 46 to 50 further explore the effect of dietary modification on growth in pre-school children.

Over the past decade high fibre diets have been promoted for older children and adults to help prevent constipation and diverticular disease (Burkitt 1980, NACNE 1983). Whilst many other health claims have been made for the beneficial effects of fibre, or non-starch polysaccharide as it is now preferentially termed, a recent report by the British Nutrition Foundation found no evidence to substantiate or refute the hypotheses on the protective effect of non-starch polysaccharides in "western diseases". The report promoted a diet rich in starch, or complex carbohydrate, and warned against the use of excess wheat bran in children (BNF 1990). Table 46 compared the effect on growth and nutrient intake of diets rich in fibre to those with a poor fibre content. There is a notable mean age difference between the two groups of almost one year, which may be related to the bulkier nature of high fibre foods which are possibly less palatable to young children. However, despite the bulkier nature of a high fibre diet, these children had no difficulty in maintaining energy intake and had a surprisingly high mean weight percentile compared to children taking a low fibre diet. The nutrient profile of children taking a high fibre diet was also much more favourable than that of children taking a low fibre diet, with a significantly lower intake of fat ($P<0.05$) and a significantly higher intake of starch, iron and thiamin

(P<0.001). The conclusion from Table 46 is that high fibre diets do not impair growth in pre-school children and may indirectly benefit future health by favourably modifying the fat, starch and iron content of the diet. In young children who find high fibre foods impalatable, the promotion of low fibre starchy foods such as white breads, breakfast cereals and pasta would also contribute towards a reduction in fat intake and an increase in the starch and iron content of the diet.

In this study of pre-school children, a surprisingly large number (13%) were taking a very low fat diet of less than 30% energy from fat. However, an equally large number (15%) were taking more than 40% of energy from fat (Table 47). Of significance is the isocaloric energy intake of both groups, suggesting an innate ability of healthy children to control energy balance. However, neither group of children could be said to be taking an ideal diet. Those on a low fat diet had an exceptionally high mean sugar intake of 36% of energy, significantly contributing to maintenance of energy intake. Much of this sugar was derived from pure fruit juices, which though 'natural', are also associated with fruit acids, such as malic acid from apple juice and citric acid from orange juice, that promote corrosion in teeth enamel (Table 48). The starch intake of children on a low fat diet was significantly higher than those on a high fat diet, but at 23% of energy intake was not exceptionally high. Comparing growth parameters of children taking a low fat diet to those taking a high fat diet it can be seen that there are no apparent differences in height or body composition of the two groups. Thus, irrespective of our views of the composition of a low fat diet as taken by children in this study, a low fat diet in the range of 26% - 30% of energy from fat is not in itself necessarily a cause of growth failure in pre-school children.

As low fat + high fibre diets are now promoted for adults it is not uncommon for children to receive this type of diet. Such diets are extremely bulky as they are of a low energy density. The term 'meusli children' was introduced during the mid 1980s in reference to 'failure to thrive' children who were believed to be taking such diets (Francis 1986). A small group of pre-school children in this study (n = 6) were identified as taking bulky high fibre + low fat diets, and compared to those taking, in contrast, energy dense high fat + low fibre diets (Table 49). The results of this comparison provide no evidence to suggest that healthy children taking a high fibre + low fat diet of 'western' foods, are unable to maintain growth or nutrient intake. On the contrary, children taking a low energy dense diet were significantly heavier in terms of weight percentile than children taking a concentrated form of diet.

Advice on the modification of diet can only ever be effective if it is accompanied by practical steps towards achieving the desired goal. Semi-skimmed milk is now widely available and is a useful means of reducing fat intake in older children and adults. Its use has been cautiously condoned in the UK for use in children over 2 years of age, though full-fat milk is still widely preferred for pre-school children (DHSS 1988). Table 50 compares the growth parameters and nutrient intake of children taking semi-skimmed milk to those taking full-fat milk. No significant differences were found between the two groups in the attained growth or in apparent body composition. There were however, appreciable differences in the composition of the diet, children taking semi-skimmed milk having a significantly lower fat intake and a significantly higher starch intake ($P<0.001$) than children taking full-fat milk. Interestingly, there is no significant difference in sugar intake between the two groups. These favourable dietary modifications, as regards reducing the risk of future cardiovascular disease, may not be wholly attributable to the effect of substitution of semi-skimmed milk in the diet, but may be partly related to a move towards a healthier diet by the families of children taking semi-skimmed milk. Nevertheless, Table 50 demonstrates that semi-skimmed milk is a useful means of reducing the fat content of the diet of pre-school children; and also, that it is possible to significantly reduce the fat content of the diet of pre-school children without significantly increasing sugar intake. Promotion of the use of semi-skimmed milk in the diet of pre-school children is therefore a simple and practical step towards achieving a healthier diet.

CONCLUSIONS.

INVESTIGATION OF FACTORS INFLUENCING THE EATING HABITS OF PRE-SCHOOL CHILDREN.

The **eating patterns** of pre-school children were found to closely resemble family eating patterns, suggesting that eating habits are formed at a very early age. However, compared to older children and adults, young children had a lower intake of fat and a higher intake of sugar.

Fluoride and vitamin preparations were not widely given. Commercial vitamin supplements were more frequently used than inexpensive DOH vitamin drops.

Dental hygiene: Although most children cleaned their teeth at least once daily, a large proportion of children were doing so without the supervision of an adult, therefore dental hygiene was far from ideal. Sugar intake was not related to the incidence of dental disease.

Bowel habits: No evidence was found to suggest that the composition of the diet or intake of dietary fibre affected frequency of bowel motions.

Food allergy: At 8%, the incidence of reported food allergy was high. Milk and eggs were the most common allergens. Few children had received adequate dietetic advice.

ASSESSMENT OF THE NORMAL RANGE AND MEAN INTAKE OF ENERGY AND NUTRIENTS OF PRE-SCHOOL CHILDREN AGED 2 - 5 YEARS.

Energy intake: The mean daily energy intake was 20% - 25% lower than previously estimated by dietary survey and 15% - 20% lower than the current UK Estimated Average Requirements of energy, but compared favourably with recent estimates of total daily energy expenditure by the doubly labelled water technique.

Little variation was found between children of ages 2, 3 and 4 years in sources of energy intake.

Fat intake: Intake of fat, at 34% - 36% of energy, was lower than recorded in previous studies, but similar to the estimated fat intake of children in recent non-UK studies. The % of energy obtained from saturated fat was high with levels in excess of 15% - 16% at two years of age.

Carbohydrate intake: The total **sugar** intake of children was high in comparison to the reported intakes of older children and adults, at a mean intake of 29% - 31% of energy. Intake of **starch** ranged from 9% - 34% of energy, with mean group intakes of 19% - 22% of energy intake. Starch intake was found to 'track' significantly during the pre-school years, thus encouraging a high intake of starchy foods at an early age could help to reduce intake of sugar and fat.

Dietary fibre: With mean group intakes of 8g - 11g per day, fibre intake was relatively high compared to adults. Strong positive relationships were found to exist between the intake of energy and dietary fibre, and between the intake of starch and dietary fibre.

Vitamins and minerals: Group mean intakes of vitamins and minerals were at or above RNI values, except for an exceptionally low intake of vitamin D by all groups of children and a low intake of iron by 2 year old children. Minimal intakes of a wide range of vitamins and minerals were as low as LRNI values in all groups of children; thus a small minority of children were at risk of vitamin and mineral deficiencies.

Nutrient intake and socioeconomic status: No significant trends in nutrient intake were apparent across the socioeconomic spectrum for either boys or girls. However there were similarities in trends in the intake of fat, sugar and fibre compared to a recent national survey of British adults.

INVESTIGATION OF THE INFLUENCE OF VARIATION IN DIETARY COMPOSITION ON NUTRIENT INTAKE, AND OF THE RELATIONSHIP BETWEEN INTAKE OF NUTRIENTS.

Energy density and energy intake: No significant relationship was found between energy intake and the composition of the diet, or between % of energy from sugar, fat and protein and parameters of growth, implying that young children are able to regulate energy intake by adapting to variations in the energy density of their diet. A strong tendency was found for fat and sugar to compensate for each other to maintain energy intake.

Diet composition and micronutrient intake: Variations in macronutrient intake, expressed as % of energy from fat, sugar, starch and protein were found to significantly affect the quality of diet in terms of the concentration of micronutrients. Improving starch intake and reducing sugar and fat intake could significantly increase the intake of vitamin B1, niacin, vitamin B6, vitamin D, fibre, iron and zinc.

Children with a low intake of one vitamin or mineral were found to have a low intake of a range of associated nutrients. As intake of vitamins and minerals tend to "track" during the pre-school years, marginal intakes were protracted.

COMPARISON OF GROWTH PARAMETERS TO CURRENT UK STANDARDS OF GROWTH.

The **anthropometric assessments** suggested that the children were growing well, despite considerable variation in nutrient intake.

For both boys and girls group mean values for **weight** were close to the 50th percentile values. Some children were overweight, none were obese. Group mean values for **height** were well above the 50th percentile.

Mean group values for **triceps and subscapular skinfold thicknesses** were well below the 50th percentile of the current UK standard charts. It is suggested that the UK standard charts require updating.

Anthropometric parameters and socioeconomic status: For boys and girls there were no significant differences in height across the socioeconomic spectrum. However, there was a significant negative association of weight with socioeconomic group in girls only, those from socioeconomic groups IV and V tending to be lighter.

ASSESSMENT OF THE INFLUENCE OF VARIATION IN DIETARY COMPOSITION ON GROWTH.

Energy: Significant correlations for energy intake with height and weight of 0.48 and 0.53, respectively were found. It is concluded that, as body mass increases, this effect is related to greater basal energy requirements and higher energy expenditure in physical activity, as variation in energy intake had no influence on height velocity.

Sources of energy: Variation in sources of energy also had no effect on attained growth or height velocity.

Vitamins and minerals: No relationship was found between intake of minerals and vitamins and growth velocity, implying that although some children had low intakes in relation to DRVs, nutrient intakes were adequate to sustain growth.

Modified diets: No evidence was found to suggest that children taking low fat and/or high fibre diets were unable to maintain nutrient intake or growth.

The use of **semi-skimmed milk** was found to be a simple and practical means of achieving a healthier diet.

It is concluded that dietary modifications in early childhood which seek to lower the intake of fat and sugar and increase the intake of starch, do not have a detrimental effect on growth.

Such modifications, aimed at reducing morbidity and mortality in adulthood, significantly improve the intake of vitamin B1, niacin, vitamin B6, vitamin D, fibre, zinc and iron and if instigated at an early age are more likely to be sustained into adulthood.

Pages 275 to 282 are left intentionally blank.

RECOMMENDATIONS FOR FUTURE RESEARCH.

i. It is recommended that the energy intake and energy expenditure of pre-school children are assessed simultaneously.

Simultaneous assessment of energy intake and energy expenditure would enable the validation of diet survey methodology and provide confirmation of the conclusion of this survey which found the energy intake, and thus energy requirements, of pre-school children to be 20% - 25% lower than previously estimated by dietary survey.

ii. It is recommended that the nutrient intake and growth of a cohort of children is monitored longitudinally from the pre-school years, throughout childhood, to evaluate the long-term influence of variation in dietary composition on nutrient intake and growth.

iii. It is recommended that, in conjunction with ii. above, the blood lipid profile of children is monitored longitudinally to assess the influence of dietary lipids and the P:S ratio on blood lipids.

iv. It is recommended that a cross-sectional dietary survey of pre-school children is undertaken every 5 - 10 years to assess the influence of changing dietary practices and beliefs on the nutrient intake of pre-school children.

APPENDIX 1

STATIONERY

Contents.

DEPARTMENT OF CHILD LIFE AND HEALTH
17 Hatton Place
Edinburgh
EH9 1UW

Telephone: 031-667 2617
Telex: 727442 (UNIVED G)

Dear

As a post-graduate student I am in the process of collecting data for my research project entitled "A Nutritional Study of Pre-school Children in Edinburgh". This study involves approximately 200 children between the ages of 2 and 5 years from several areas of Edinburgh, including Currie/Balerno, Wester Hailes, Trinity, Leith and now also EH11 and EH12. Names are chosen at random from the Lothian Child Health Register.

For each child data is collected in the form of a 7 day weighed food intake, 24 hour food recall, Eating Behaviour Questionnaire and anthropometric measurements of height, weight, triceps and sub-scapular skinfold thicknesses and mid-arm and mid-calf circumferences. All appointments with the child and mother are in their own home. It is hoped that at least 100 of these children will repeat the exercise 1 year later.

Overleaf is a list of children who have been selected from your medical practice. I would be grateful if you could inform me by .... if any of these children are unsuitable to approach on either medical or social grounds. An invitation to participate in the study will then be sent by letter to the parents of the remaining children. I aim to study healthy children of a wide social background and will include children from ethnic minorities should their names be randomly selected.

This study has been granted ethical approval from both the Obstetric and Paediatric ethical committee and the Community Medicine/General Practice ethical committee. It has been partly funded by the British Heart Foundation and the Nutritional Consultative Panel.

Yours sincerely,

Mrs Anne Payne BSc SRD
(Post-graduate student)

DEPARTMENT OF CHILD LIFE AND HEALTH
17 Hatton Place
Edinburgh
EH9 1UW

Telephone: 031-667 2617
Telex: 727442 (UNIVED G)

University of Edinburgh

Professor: N. McIntosh
Senior Lecturers: N.R. Belton
W.A.M. Cutting
R. Hume
R.A. Minns
(Child Psychiatry) P. Hoare
(Surgical Paediatrics) G.A. MacKinlay

Dear

I am writing to invite you and your son/daughter .... to take part in a "Nutritional Study of Pre-school Children", aged 2 to 5 years. Your child's name has been chosen at random from the Lothian Child Health Register.

If you are willing to take part in the survey we will ask you to keep a weighed record of all the food your child eats in one week. I will arrange to visit you in your home to give you a set of our scales and to talk over our clear instruction sheets. You are free to drop out of the survey at any time, though if you agree to take part, we do hope you will complete it.

We will also take growth measures of your child, such as height and weight, and I will ask some questions about your child and families eating habits. In all, I will make 3 short visits to your home of up to 1 hour each.

The results of this study will help us to understand how the growth and health of young children is affected by the type of food they eat.

This study has been partly sponsored by the British Heart Foundation and the Nutritional Consultative Panel.

You will find a reply slip with this letter. Could you please fill it in and return it to me in the stamped addressed envelope.

Thank you for your help,

Yours sincerely,

Mrs Anne Payne BSc SRD

I Would like you to call to explain the study. ☐

I do not want to take part in the study. ☐

Please tick.

Signed: ....

Address: ....

....

....

Tel.No. ....

It would be convenient for you to call on week beginning

.... On:

	9.30 - 11.00	2.00 - 4.00.
Monday	☐	☐
Tuesday	☐	☐
Thursday	☐	☐
Friday	☐	☐

Please tick suitable times.

<u>Please Note</u>

I will telephone/write to confirm a suitable appointment with you.

Thank you,

Anne Payne

DEPARTMENT OF CHILD LIFE AND HEALTH
17 Hatton Place
Edinburgh
EH9 1UW

Telephone: 031-667 2617
Telex: 727442 (UNIVED G)

University of Edinburgh

Professor: N. McIntosh
Senior Lecturers: N.R. Belton
W.A.M. Cutting
R. Hume
R.A. Minns
(Child Psychiatry) P. Hoare
(Surgical Paediatrics) G.A. MacKinlay

D.O.B.
AGE. M/F
Ref.No.

NAME

ADDRESS

The results of this survey will help us to understand how the growth and health of young children is affected by the type of food they eat.

This survey has been partly sponsored by the British Heart Foundation and the Nutritional Consultative Panel.

It is very important that the information you give us is as accurate as possible.

We are very grateful for the help and support that you and your family are giving this study.

DEPARTMENT OF CHILD LIFE AND HEALTH
17 Hatton Place
Edinburgh
EH9 1UW

Telephone: 031-667 2617
Telex: 727442 (UNIVED G)

University of Edinburgh

Professor: N. McIntosh
Senior Lecturers: N.R. Belton
W.A.M. Cutting
R. Hume
R.A. Minns
(Child Psychiatry) P. Hoare
(Surgical Paediatrics) G.A. MacKinlay

A NUTRITIONAL STUDY OF PRE-SCHOOL CHILDREN IN EDINBURGH.

7 DAY WEIGHED FOOD INTAKE

Introduction

1. All the instructions you need are printed on the coloured pages.

   PLEASE READ THESE INSTRUCTIONS CAREFULLY.

   An example of how to record a 1 day food intake is also given.

2. Record your childs food intake on the white pages, starting each day with a new page.

3. Your child should eat EXACTLY AS HE/SHE NORMALLY DOES.

4. Food and drinks taken over a period of 7 full days must be recorded, including a Saturday and a Sunday.

5. Full instructions for using the scales are given on page 5.

6. The following equipment has been provided:

Electronic scales	Non-slip bowl
Notebook	Light-weight plate
Ruler	Measuring spoons
Pen	Small fluid measure.

   The notebook has been given to record food and drink eaten away from home. Transfer the information from your notebook into the Home Record Book when you get home.

7. It is important that all the information you give is as accurate as possible. If you are having any doubts or difficulties do not hesitate to telephone for help.

Telephone : Anne Payne (031) 337 - 6485.

ALL THE INFORMATION RECEIVED IN THIS SURVEY IS CONFIDENTIAL.

Thank you for your cooperation.

CONTENTS

DESCRIBING FOOD AND DRINKS

A GOOD DESCRIPTION OF ALL FOOD AND DRINKS IS VERY IMPORTANT.

1. PACKAGED/MANUFACTURED FOODS.

Eg. Breakfast cereals; Milk; Bread; Biscuits; Sweets; Crisps; Fruit juice; Butter and Margerine; Yoghurt; Baked beans; Soup; tinned fruit and vegetables; frozen foods etc.

BE SPECIFIC ABOUT THE TYPE OF FOOD OR DRINK EATEN, ie:

MILK - is it full-fat milk, skimmed milk or semi-skimmed?
TINNED FRUIT - is it in syrup or natural fruit juice?
BREAD - is it white, wholemeal or brown bread?
YOGHURT - is it natural, sweetened or sugar-free fruit?

IF POSSIBLE, GIVE BRAND NAMES, ie.

NOT THIS WAY	BUT THIS WAY
Fruit juice	Orange juice, Libby's Vit C
Chocolate	Cadbury Wildlife bar price 12p
Crisps	Crisps, KP ready salted, price 15p
Beans	Baked beans in tomato sauce, Heinz.

2. COOKING FOODS.

State how the food was cooked ie. boiled, fried, grilled etc.

If a food is fried, STATE WHAT TYPE OF FAT OR OIL WAS USED. eg lard, olive oil, flora oil.

Always state if SALT has been added, ie. write SALT ADDED.

3. MEAT.

a. Type?
b. How is it cooked? Is salt added?
c. Have other ingredients been added, eg vegetables?
c. Is it lean or fatty? DESCRIBE.
d. Does weight include a bone? (See "Weighing Left-overs").

NOT THIS WAY	BUT THIS WAY
Stew	Beef shoulder steak, stewed with onions, carrots, oxocube, thickened with Bisto. Salt added.(See Recipe)
Sausages, fried	Pork sausages, Walls, fried in White Cap.
Grilled chop	Lamb loin chop, lean and fat grilled. Weight includes bone.

IF POSSIBLE, WEIGH COOKED MEAT SEPARATELY FROM THE GRAVY.

4. FISH.

a. Type?
b. It is tinned or fresh, smoked or unsmoked?
c. How is it cooked? Is salt added?
d. If fried, is it coated in breadcrumbs only, egg + breadcrumbs, or batter?

NOT THIS WAY	BUT THIS WAY
Fried fish	Fresh fish, haddock, coated in egg and breadcrumbs, fried in Mazola oil.
Tuna fish	Tuna fish, canned in oil, John Wests.
Smoked fish	Smoked haddock, poached in milk. No salt added. Milk disgarded after cooking.

5. FRESH FRUIT and VEGETABLES.

a. Is it peeled or unpeeled?
b. Raw or cooked?
c. Method of cooking? eg Baked, boiled, fried?
d. Does it have added salt, sugar, or artificial sweetener?

NOT THIS WAY	BUT THIS WAY
Apple	Apple, eating, with skin and core.
Orange	Orange, peeled.
Pears	Pears, peeled and cored, stewed with sugar (see recipe).
Chips	Chips, home-made from peeled potato, fried in lard.
Carrots	Carrots, boiled, salt added.

6. HOME-MADE COOKED DISHES.

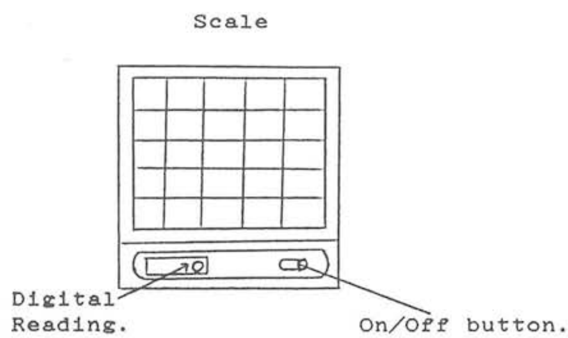
It would be very helpful if you could write down your usual recipe for making stews, soups, puddings etc. Examples of how to do this are given on page 11.

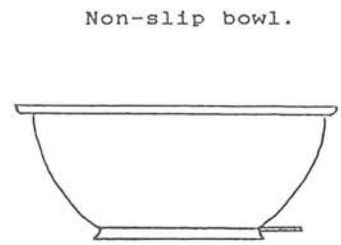
You will find sheets of lined paper at the back of your Home Record Book to use for writing down your recipes.

In general, you should give:

a. A description of the ingredients and their individual weights.
b. The weight of the final cooked dish, (See "using the scales").
c. The weight of the portion served.

USING THE SCALES.





1. To switch ON - Press the On/Off button.
   Wait for a few seconds until a single O appears.

2. To switch OFF - FIRMLY press the On/Off button TWICE.

   After the first press a row of OOOO appears.
   IMMEDIATELY press again to switch off.

   Note If you do not switch off the scales they will switch themselves off after 3 minutes.

   If (----) appears when using the scales, press the on/off button to set the scales to O before weighing the next item.

3. Using the non-slip bowl.

   The scales can be used with or without the non-slip bowl.

   If using the bowl, either:

   a. Sit the non-slip bowl on the scale before you switch on. Press the on/off button, the scale will set itself to zero.

   or

   b. Press the on/off button, wait until O appears.
      Sit the bowl on the scale, press the on/off button again.
      Wait until O appears.

   ITEMS AND MEALS CAN NOW BE WEIGHED IN THE USUAL WAY.

   Note
   The non-slip bowl is helpful as a base if you want to use a large plate, as it lifts the plate up, allowing you to see the digital readout more easily.

   DO NOT SIT VERY HOT ITEMS DIRECTLY ONTO THE SCALE

WEIGHING MEALS

PRACTICE WEIGHING MEALS SEVERAL TIMES BEFORE YOU BEGIN THE SURVEY.

EXAMPLES OF WEIGHING AND DESCRIBING MEALS ARE GIVEN ON THE SAMPLE MENU.

1. Switch on scales, wait until O appears.

2. Put the plate on the scales, write down its weight and write "Plate" in the description column. Leave the plate on the scales.
   eg. Plate 200g

   NOTE The weight of the plate is needed to allow us to estimate the weight of left-over food, see "weighing left-overs".

3. Set the scale to zero by pressing the on/off button again, wait until O appears.
   Put the first item of food on the plate, eg 2 grilled fish fingers. Write the new weight in the weight column.

   eg. 2 Findus cod fish fingers 60g

5. Set the scales to O. Put the next item of food on the plate eg baked beans, write the new weight in the weight column and describe.

   eg. Heinz baked beans in tomato sauce 74g

6. Set the scales to O. Add the next item eg. Boiled potatoes, write its weight in the weight column and describe.

   eg. Boiled potato 96g

7. Continue to add items and weigh in the same manner.

DON'T FORGET TO DESCRIBE EACH ITEM AS IT IS ADDED

PLEASE REMEMBER

All parts of the meal MUST be weighed separately, eg fish fingers, baked beans, potato; also gravies and coating sauces if included.

Do NOT give only the total weight for all items. An exception would be something like macaroni cheese which is a complete meal in itself.

WEIGH SOUPS AND DESSERTS IN THE SAME WAY.

WEIGHING LEFT-OVERS

When the meal is finished leave the left-over food on the plate and weigh the plate and food together.

1. Set scale to 0. Sit plate with left-over food on scale. Read weight.

2. Write the total weight in the "left-overs" column.

As we already know the weight of the plate (see weighing meals), I can now easily calculate the weight of the left-over food.

ALSO describe the left-overs, eg:

Plate + one fish finger + 1 teaspoon potato	350g
or:	
Plate + half of mixture remaining.	350g
(food mashed together before eating)	

Note 1.
If it is not too messy, then it would be helpful if you could weigh individual items separately, by scraping them into the non-slip bowl one at a time.

REMEMBER TO SET THE SCALE TO ZERO BEFORE WEIGHING EACH ITEM

Note 2.
If a portion of meat containing a bone was served, then the remaining bone should be weighed separately as a left-over and described as "bone".

WEIGHING SNACK FOODS.

This includes biscuits, cake, fruit, sweets.

1. Switch on scales. Wait until 0 appears.

2. Place item on scales, read weight.

3. Write weight of item in weight column. Describe item. Note: If more than one item has been weighed, give the number of items with the description, (eg "2" digestive biscuits).

4. Weigh left-overs, if any, in the same manner as above or estimate amount and record in left-over column.

5. Some items have standard weights, eg certain sweets and biscuits. You do not need to weigh these providing you record the size on the wrapper.

   eg. 1 standard Mars Bar, size 62.5g.

   1 milk Bounty (2 pieces), size 58g.

WEIGHING DRINKS

All drinks, including plain water, should be weighed.

To record the weight:

1. Switch on scales, wait until O appears.

2. Sit the mug, cup or tumbler on the scales, write its weight in the weight column and describe. Remove cup. The scales will return to zero.

3. Pour the drink. Replace cup on scale and read the new weight, (ie cup + drink). Write total weight in the weight column.

4. If there is more than one item in the drink, continue to weigh the cup after each addition.

eg	cup	weight = 150g
	cup + Orange squash	Weight = 170g
	cup + Orange squash + water	Weight = 270g

Note
Unlike weighing solid food, you are asked to remove the cup from the scales before adding each part of the drink as spilt liquid could damage the scales. Also, you cant take a tap to the cup!

5. Drinks should be weighed each time they are taken and the weight recorded.

6. If any drink is left over record the weight of the cup/tumbler of drink in the "left-over" column.

7. If an individual can, carton or bottle is opened there is no need to weigh it at the start, providing exact details of its contents are given:

   eg 1 200ml carton pure apple juice.

   However, any drink left-over should be either:

   a. Weighed if possible, using a pre-weighed cup. Or,

   b. Estimated, if eating out, eg half carton remains.

MAKING SANDWICHES

1. Switch on scale, wait until O appears.

2. Place bread on scale. Record its weight and describe.

   eg. Bread 60g

   Remove bread. The scales now return to zero.

3. Spread margerine or butter onto bread. Return bread to scale. Record its new weight and describe.

   eg. Bread and butter 75g

   Remove buttered bread, the scales return to zero.

4. Add filling to bread, eg. cheese, jam, or cold meat. Return sandwich to scale. Record its new weight and describe.

   eg. Bread + butter + cheddar cheese. 100g

5. If part of the sandwich is not eaten, record its weight in the left-over column and describe.

   eg. Half cheese sandwich 50g

FOOD PREPARED AT HOME BUT EATEN AWAY FROM HOME eg picnics.

1. Weigh the food in the usual way as it is being prepared and write the description and weights down in the record book. Give the time that you intend to eat.

2. When you are out, use your notebook to record what was actually eaten, the time, and what was left over.

   eg: 2 home-made cheese rolls - 1 eaten - 12.15pm
   1 left-over.

3. If part of the meal is later eaten as a "snack", then this should be noted and the time stated.

   eg: 1 home-made cheese roll - 4.00pm

4. Any other food eaten away from home should be recorded and described as far as possible in the notebook.

   eg. 1 can Coca-Cola 330ml
   1 orange Jacob Club biscuit.

FOOD AND DRINK EATEN OUTSIDE THE HOME (Using your notebook).

1. A small notebook has been provided for you/your childminder etc. to keep a note of any food eaten outside the home. The information can be transferred to your home record book when you return.

   ENSURE THAT YOUR NOTEBOOK IS ALWAYS CARRIED OUTSIDE THE HOME.

2. Make a note of foods eaten in as much detail as possible.

   Weigh everything you can. However, if you are unable to weigh the food and drink describe it and the amount as best as possible. A small ruler and measuring spoons have been provided to help you estimate portion sizes.

   Give the shop name and brand name if appropriate.

eg.	Scotch pie (Hall's)	half eaten.
	Smash mashed potato	1 ice-cream scoop.
	Garden peas (Safeways)	2 heaped tablespoonfuls.
	Slice rich fruit cake	1"x 2"x 3".
	Fresh milk	1 Wimpy "small" carton.

3. A small 50ml fluid measure has been provided to help you measure drinks away from home.

eg.	Fresh milk,	Wimpy "small" carton.
OR	Fresh milk, from Wimpy,	150ml (3 measures)

HOW TO RECORD YOUR RECIPES

At the back of this folder you will find some blank sheets for writing down your recipes.

It is important to give the weight and a description of each ingredient, including any water that is added. Also, give a brief outline of the cooking method used.

If possible, give the weight of the food after cooking.

EXAMPLES

Beef Stew

Ingredients:	Weights.
Diced stewing steak	460g
Plain flour	2 tsp
Onion, peeled	100g
Carrot, peeled	100g
Oxo cube	one
Lard for browning	20g
Water added	300g
SALT ADDED.	

Method

Meat dipped in flour, then browned in lard with onion.
Remaining items added, stewed 1 hour.

Final weight of stew, before serving.	750g

Sultana scones

Ingredients:	weights.
White S.R. flour	230g
Blue band margerine.	55g
Sugar	55g
Full-fat milk	150g
Sultanas	100g

Method
Scones made in normal way.
Made 8, 1 weighs 55g

NOTES
DO NOT SIT VERY HOT DISHES DIRECTLY ONTO THE SCALES

POUR HOT FOOD, LIKE STEW, INTO A BOWL BEFORE WEIGHING.

IF YOU USE THE SAME RECIPE TWICE, IT ONLY NEEDS TO BE RECORDED ONCE.

NAME: Sample Menu   DATE: 10-2-88   DAY OF WEEK: Wednesday

TIME	FOOD	DESCRIPTION	GRAMMES WEIGHT	GRAMMES LEFT-OVER	OFFICE USE	
8.30am	mug		255			
	mug + milk	full-fat	395			
	bowl		304			
	2 weetabix	real brand	42			
	milk	semi-skimmed	143			
	left-overs:	weetabix + milk in plate		359		
11am	cup	feeding cup + lid	38			
	cup + ribena	blackcurrant	58			
	+ water		137			
	penguin	chocolate biscuit	23			
	left-overs:	ribena in cup (with lid)		92		
		half penguin		12		
12.30	bowl		304			
	tomato soup	Heinz, cream of tomato	150			
	Bread	1 slice mighty white	37			
	bread + butter	salted Lurpak	46			
	cheese	yellow cheddar	25			
	left-overs:	soup in plate		344		
		buttered bread		22		
3.00pm	coca-cola	1 full can	330			
	apple	whole	105			
	left-overs:	2 small measure-full coca-cola				
		apple core		26		
5.30pm	plate		90			
	potato	peeled and boiled in salted water	52			
	beef stew	see my recipe	92			
	garden peas	frozen, boiled in salted water	48			
	left-overs:	plate+ 2 tsp peas + some stew		125		
	bowl		256			
	ice-cream	Bejam pure white vanilla	63			
	peaches	Del Monte tinned in fruit juice	73			
7.00pm	cup	feeding cup + lid	38			
	cup + milk	semi-skimmed	105			
	biscuit	1 McVities plain digestive	16			

NAME DATE DAY OF WEEK

TIME	FOOD	DESCRIPTION	GRAMMES		OFFICE USE	
			WEIGHT	LEFT-OVER		

Universityof Edinburgh

ANTHROPOMETRIC MEASUREMENTS I.

	Ref. No.		1 - 6
	Date.		7 - 12
	D.O.B.		13 - 18
Name:	Age.		19 - 20
Weight (Kg)	Average		21 - 23
1. 2.	Percentile		24 - 25
Height (cm)	Average		26 - 29
1. 2.	Percentile		30 - 31
Mid-arm circumference (cm)	Average		32 - 34
1. 2.	Percentile		35 - 36
Mid-calf circumference (cm)	Average		37 - 39
1. 2.	Percentile		40 - 41
Triceps skinfold. (mm)	Average		42 - 44
1. 2.	Percentile		45 - 46
Sub-scapula skinfold (mm)	Average		47 - 49
1. 2.	Percentile		50 - 51
Mothers Wt. (Kg) ______			52 - 55
Mothers Ht. (cm) ______			56 - 59
Mothers Age. ______			60 - 61
Fathers Wt. (Kg) ______			62 - 65
Fathers Ht. (cm) ______			76 - 69
Fathers Age. ______			70 - 71

ANTHROPOMETRIC MEASUREMENTS II.

	Ref. No.	1 - 6
	Date.	7 - 12
	D.O.B.	13 - 18
Name:	Age.	19 - 20
Weight (Kg)	Average	21 - 23
1. 2.	Percentile	24 - 25
Height (cm)	Average	26 - 29
1. 2.	Percentile	30 - 31
Mid-arm circumference (cm)	Average	32 - 34
1. 2.	Percentile	35 - 36
Mid-calf circumference (cm)	Average	37 - 39
1. 2.	Percentile	40 - 41
Triceps skinfold. (mm)	Average	42 - 44
1. 2.	Percentile	45 - 46
Sub-scapula skinfold (mm)	Average	47 - 49
1. 2.	Percentile	50 - 51
	Height velocity (cm)	72 - 74
	Percentile	75 - 76
	Mid-parent height (cm)	77 - 79

DEPARTMENT OF CHILD LIFE AND HEALTH
17 Hatton Place
Edinburgh
EH9 1UW

Telephone: 031-667 2617
Telex: 727442 (UNIVED G)

University of Edinburgh

Ref. No. ☐☐☐☐☐☐ 1-6

DIET SURVEY QUESTIONNAIRE.

Social details. OFFICE USE

1. (a) Number of children in family. ____ ☐ 7.

   (b) Position of child in family. ____ ☐ 8

2. (a) Mothers profession/occupation, ☐ 9

   (b) If working, full-time or partime? ____ ☐ 10

3. (a) Fathers occupation. __________ ☐ 11

   (b) If unemployed, former occupation. __________ ☐ 12

4. Age at leaving full-time education?. ☐☐ 13-14

   (a) Mother ____ (b) Father ____ ☐☐ 15-16

5. Nationality of parents. ☐ 17

   (a) Mother ____ (b) Father ____ ☐ 18

6. (a) Does the FAMILY adhere to any specific diet? ____ ☐ 19

   (b) If yes, what? __________ ☐ 20

Eating Behaviour

7. (a) Which of the following meals are eaten sitting at a table?

   Breakfast ____ Lunch ____ Dinner/Tea ____ ☐ 21

   (b) During WEEKDAYS, which, if any, of the following meals does the family usually eat together?

   Breakfast ____ Lunch ____ Dinner/Tea ____ ☐ 22

   (c) During WEEKENDS, which, if any, of the following meals does the family usually eat together?

   Breakfast ____ Lunch ____ Dinner/Tea ____ ☐ 23

   (d) Which, if any, of the following meals and snacks does your child usually eat whilst watching television?

   MEALS: Breakfast SNACKS: Mid-morning ____ ☐ 24

   Lunch Mid-afternoon ____

   Dinner/Tea Bedtime ____

   Or, NONE as we do not have a television. ____

OFFICE USE

8. (a) Is your child able to eat with a :

Spoon Fork Knife and fork Other? ____ [ ] 25

(b) Which of the following does your child most often eat a meal with? [ ] 26

Fingers alone	Fingers + spoon	____
Spoon alone	Spoon + fork	____
Fork alone	Knife + fork	____
Other?		

9. (a) If your child will not eat the meal you have prepared and served, would you usually : [ ] 27

a. Give him/her something else? ____

b. Tell him/her to leave it, but give no alternative? ____

c. Spend time coaxing him/her to eat as much as possible? ____

(b) If your child is struggling with a meal, do you manually help to feed him/her? ____ [ ] 28

10. Do you usually prepare the same food/meals for your child as: [ ] 29

a. Other children in the family. ____

b. Other adults in the family. ____

c. No-one - takes separate food. ____

11. Do any of the following statements apply to your child? [ ] 30

a. Has a good appetite. ____
b. Has a poor appetite. ____
c. A "fussy eater", having many dislikes. ____
d. Will eat most foods. ____
e. Other? ____________ ____

12.(a) Which of the following is your child able to drink from? [ ] 31

1. Feeding cup with spout ____
2. Plastic cup without lid ____
3. Adult cup/mug ____
4. Tumbler + straw ____

(b) Which is most often used? ____ [ ] 32

OFFICE USE

Dental hygiene / Health.

13.(a)	Do you regularly give your child fluoride drops or tablets?	___	33
(b)	If so, which?	___	34
14.(a)	Does your child clean his/her teeth with a fluoride containing toothpaste?	___	35
(b)	Are your childs teeth cleaned every day?	___	36
	If yes, how often per day?	___	37
	When?	___	38
(c)	Who most often cleans your childs teeth?	___	39
	Mother/father child	___	
15.(a)	Has your child ever visited a dentist?	___	40
	If yes, how many times?	___	41
	Time interval? (months)	___	42-43
(b)	Has he/she had any fillings?	___	44
	If yes, how many?	___	45
16.(a)	Do you regularly give your child a vitamin supplement?	___	46
(b)	If yes, which type?	___	47
17.(a)	Does your child have a known food allergy or food intolerance?	___	48
(b)	If yes, to which food(s)?	___	49-51
		___	52-54
		___	55-57
(c)	Symptoms?	___	58-60
(d)	Was this diagnosed by your doctor?	___	61
(e)	What action have you taken?	___	62
18.(a)	How frequently does your child usually pass a stool?		
	1. More than once daily. ___ 2. Once a day. ___ 3. Every 2 or 3 days ___ 4. Once weekly ___ 5. Don't know ___		63

OFFICE USE

(b) Is your child prone to constipation? ____ 64

(c) If so, what treatment, if any, do you give? 65

____

Behaviour

19. (a) Does your child have a regular bedtime? ____ 66

If yes, usual time? ____ 67-69

(b) What time does he/she usually wake? ____ 70-72

Therefore no. of hours sleep: ____ 73-75

(c) Does your child have any sleep problems? ____ 76

If yes, what? ______________ 77

(d) Does your child have a daytime nap? ____ 78

20. Below is a list of descriptions of behaviour often shown by young children. Do any of these descriptions apply to your child? 79

Answer Yes (Y), No (N), or Sometimes (S).

a. Very restless, cannot sit still for more than a few minutes. ____
b. Has frequent temper tantrums. ____
c. Is often disobedient. ____
d. Bullies other children. ____
e. Happy to play quietly alone. ____
f. Enjoys looking at books. ____

21. Which description do you think best suits your child? 80

1. Quiet and well-behaved. ____
2. Quiet but <u>un</u>attentive. ____
3. Lively but well-behaved. ____
4. Lively and <u>un</u>attentive. ____
5. Other? ____

Family Eating Habits

22. When you are shopping for food for the family, which, if any, of the following influences your choice? Answer F (frequently), R (rarely), or S (sometimes).

a. Cost of food. ____ 81
b. Choice in available shops. ____ 82
c. Ease of preparation and cooking ____ 83
d. T.V. advertising about foods. ____ 84
e. Concern about nutrition. ____ 85

OFFICE USE

23. We would like to compare your childs eating habits to that of your family. For the following questions answer:

1. Daily
2. 4-5 times weekly
3. 2-3 times weekly
4. Once weekly
5. Fortnightly
6. Monthly
7. Occasionally
8. Seasonally
9. Never

How often did you usually give:	CHILD	FAMILY	
Full-fat milk	___	___	86-87
Semi skimmed milk	___	___	88-89
Skimmed milk	___	___	90-91
Polyunsaturated margarines	___	___	92-93
Hard/soft table margarine	___	___	94-95
Low fat spread.	___	___	96-97
Butter.	___	___	98-99
Cottage cheese	___	___	100-101
Full-fat cheddar type cheeses	___	___	102-103
Reduced fat cheeses.	___	___	104-105
Cream cheese	___	___	106-107
Fresh/frozen red meat ie beef, lamb, pork, ham or bacon.	___	___	108-109
Liver or kidney	___	___	110-111
Meat products eg. sausages, pies, beefburgers	___	___	112-113
Chicken or turkey	___	___	114-115
White fish eg haddock, cod, smoked haddock	___	___	116-117
Oily fish (eg herring, mackeral, trout, kipper)	___	___	118-119
Tinned oily fish (eg sardines, tuna, salmon)	___	___	120-121
Eggs (as a meal)	___	___	122-123
Fresh/frozen green or root veg (eg peas, green beans, carrots)	___	___	124-125

OFFICE USE

Tinned vegetables eg peas, carrots	___	___	[ ][ ]	126-127
Salad, ie raw vegetables.	___	___	[ ][ ]	128-129
Boiled, baked or mashed potato	___	___	[ ][ ]	130-131
Chips or roast potato	___	___	[ ][ ]	132-133
(Type of oil/fat?)	___	___	[ ][ ]	134-135
Fresh fruit	___	___	[ ][ ]	136-137
Pure fruit juice	___	___	[ ][ ]	138-139
White bread or rolls	___	___	[ ][ ]	140-141
Wholemeal/bran bread.	___	___	[ ][ ]	142-143

24.(a) In relation to the above answers, what are your reasons for most frequently using a particular type of:

MILK: Child ______________________ [ ] 144

Family ______________________ [ ] 145

SPREAD: Child ______________________ [ ] 146

Family ______________________ [ ] 147

(b) In relation to the type of milk specified as most frequently used, how long have you been giving this to your:

CHILD __________ [ ] 148

FAMILY __________ [ ] 149

25.(a) When cooking, do you usually add SALT to any of the following foods? [ ] 150

1. Soup ___
2. Potatoes ___
3. Vegetables ___
4. Stew/casseroles ___

.(b) Do you usually put a salt cellar out at mealtimes? ___ [ ] 151

Answer Y (yes), N (no), S (sometimes)

(c) Is salt usually added to your childs food at mealtimes? (Answer Y, N, or S) ___ [ ] 152

DATE OF COMPLETION: [ ][ ][ ][ ][ ][ ] 153-158

APPENDIX 2

SAMPLES OF COMPLETED RECORD SHEETS

Contents.

NAME GRACE DATE 9TH SEPTEMBER '88 DAY OF WEEK FRIDAY

TIME	FOOD	DESCRIPTION	GRAMMES WEIGHT	GRAMMES LEFT-OVER	OFFICE USE	
1.30.PM	BOWL	SUPPLIED	92		647	107
	+ CHIPS	"CHIP SHOP" PORTION	260			
	LEFT-OVER			153		
	YOGHURT	ST. IVELS VERY LOW FAT PASTUERISED WITH RASPBERRIES	125g		163	125
	LEFT-OVER			–		
3.00 PM	SWEETS	1 BOX (TUBE) SMARTIES	39		857	39
	LEFT-OVER			–		
	BISCUIT	PINK WAFER	6		72	6
	LEFT-OVER			–		
	FRUIT	GRAPES, SEEDLESS, GREEN.	37		738	37
	LEFT-OVER			–		
	SWEETS	2 MARK & SPARK'S FRUIT GUMS	10		862	10
	LEFT-OVER			–		
6.00PM	FISH	DRESSED HADDOCK FRIED IN VEGETABLE OIL	74		2093	26
				48	2034	61
	CHIPS	OVEN CHIPS "BEJAM"	61			
				–	28	19
	SPAGHETTI	~~HEINZ~~ IN TOMATO SAUCE WMLOW	65			
				46	888	21
	CUP	PLASTIC PICNIC CUP	34			
	CUP+RIBENA +WATER	BLACKCURRANT	21 155	–		

NAME		DATE	DAY OF WEEK			
Graham		17/6/88	Friday			

TIME	FOOD	DESCRIPTION	GRAMMES WEIGHT	GRAMMES LEFT-OVER	OFFICE USE	
11.30	1 Slise of Bread	(Before tosting) Tostied then Sume	36g		35	26
		Pessto's soft maroan (Toast taking)	32g		190	6
		Tostied (on toast)	26g			
12.00	Cup of tea	Milk Fresh in Low	114g		1421	114
		Water	90g		843	5
		Suger	5ml			
1.30	Bag of Crispis		30g		652	30
5.30	Dineir	(Middle Left) 2 Griled Backon	30g		232	30
		Beef 1 Slied Sosige Griled	33g	17g	410	16
		Chipes in Lared	86g		645	86
	Cup of tea	Water	88g		1421	71
		Milk Fresh in low	71g			
		Suger	5ML		843	3
7.00	Sliced of Bred	Whight Bread	37g		33	37
		margerean (Pessto's)	41g		190	4
		Jam Stroberay	50g		849	9
8.30	Apial	Left With Skin on	136g		676	136
11.05	Cup of tea	milk Fresh in low	99g		1421	99
		Water	120			
		Suger	5ML		843	5

NAME Elise DATE 21/3/89 DAY OF WEEK Tuesday

TIME	FOOD	DESCRIPTION	GRAMMES WEIGHT	GRAMMES LEFT-OVER	OFFICE USE	
8.30	Cup	Feeding Cup + Lid	38			
	Cup + Milk	Full-Fat	172		1425	134
	Bowl		90	34/108 left		
	Sugar Puffs		24	− 78%	56	5
	Milk	Full-Fat	84	∴ 22% EATEN	1425	18
	Left-overs			174 ✓		
11.15am	Cup	Feeding Cup + Lid	38			
	Cup + Squash + Water	Kia-ora orange	~~[illegible]~~ 205		884	45
12.30	Plate		173		990	32
	1 Slice Toast	Hovis Wheatgerm + Flora Margarine	37		192	5
	Spaghetti Hoops	Heinz	93		28	93
	1 Apple	Peeled + cored	25		675	25
4.00 pm	Cup		39			
	Cup + Squash + Water	Kia-ora orange	153	*	884	45
5.30	Plate		175		1367	150
	Chips	Tesco oven chips	42	38 left	2034	22
	3 Fish Fingers	Birds-eye Cod-Fillet	83	182 − 48%	545	43
	Peas + Sweetcorn	Safeway Frozen Mixed	46	∴ 52% EATEN.	662	12
	Tomato Sauce	Safeway	11		623	12
	Left-overs			263		
	Creamed Rice	Ambrosia	150*		931	6
8.00 am	Cup	Feeding Cup + Lid	38		1425	146
	Milk	Full-Fat	184			
	Biscuit	1 Choc Digestive Burtons	14		63	14

NAME Cameron DATE 18/10/89 DAY OF WEEK Wednesday.

TIME	FOOD	DESCRIPTION	GRAMMES WEIGHT	GRAMMES LEFT-OVER	OFFICE USE	
8.00	bowl		90		57	16
	1 weetabix	Real Brand	106		1425	152
	+ milk	full fat	258 (total)			
	½ t.sp. sugar.				843	3
	cup		40		1425	138
	cup + milk	full fat	178			
	cup + milk + tea		268			
	1 slice toast	Sunblest white	25		35	25
	+ spread with vitalite		32		192	7
	leftovers.			NIL		
11.30	pkt sweets	M & M's	50 ?		2070	50
12.30	cup		40		2051	54
	cup + orange squash	Co-op Low Calorie	94			
	+ water		283			
12.45	white roll		40		43	40
	+ vitalite		48		192	8
	+ scrambled egg.	made with ½ teaspoon margarine + dash of milk	94		1410	46
	grated cheese	added on top of egg.	15		1521	15
	Yogurt (Melon)	Hm Low Low Fat	150		163	150
				NIL		

APPENDIX 3

CODING INFORMATION

Contents.

ADDITIONAL FOODS AND RECIPES ADDED TO COMP-EAT DATABASE.

FOODS.

Chicken pie, 1 crust; vol-au-vent
Chicken pie, 2 crust
Beef and vegetable pie; 2 crust
Chili con carne
Meat loaf
Minced beef, lean with onion
Minced beef, lean with vegetables
Pork casserole with vegetables
Steak and kidney with onion
Stewing steak with onion
Chicken casserole with vegetables
Potato salad, retail
Ratatouille
Mixed veg; canned or frozen
vegetable salad, canned
Gravy; low fat cornflour/bisto
Gravy; made with meat juices
Gravy; average
Water
Tuna fish in brine
Tuna fish in tomato sauce
Tuna in barbeque/curry sauce
Tuna; sandwich in oil
Tuna; sandwich in brine
Sardines in brine
Pilchards in brine
Farmhouse pate
Cod steaks in parley sauce
Fish steak in butter/cheese sauce
Cod steak in batter, frozen/baked
Haddock in breadcrumbs, frozen/baked
Crispy pancakes; cheese filled
Crispy pancakes; minced beef filled
Oven chips; sunflower oil/baked
Oven chips; sunflower oil/grilled
Potato waffles; grilled
Potato waffles; fried
Bovril stock cubes/granules
Beefburgers, grilled
Meatballs in gravy
Scotch pie
Baby food; savoury jars/tins
Baby food; apricot custard
Fruit juice ice lolly
Milk ice lolly
Water ice lolly

RECIPES.

Bacon and pasta
Tagliatelli Duchesse Potato
Pork chops with cheese and apple sauce
Tuna sandwich filling
Savoury rice salad
Indian fried rice
Beef and vegetable curry with potato
Lamb and mixed vegetable curry
Peas Palaoo
Garlic and rice curry
Egg and potato curry
Tomato ham and mushroom sauce
Aubergine and potato curry
Liver casserole
Low calorie coleslaw
Wholemeal pizza
Tuna and Rice bake
Spiced turkey
Paprika pork
Filled cucumber

FOODS.

Tuc snack crackers
Jordans crunchy bar
Libby's apple C
Pure apple juice (Del Monte)
Pure orange/pineapple juice
Island blend juice
Five alive; average
Five alive; light
Lilt/Fanta
Diet lilt
Hi juice squash
Reduced sugar squash
Low calorie/sugar free squash
Kio ora cartons
C-Vit blackcurrant, undiluted
C-Vit lemon barley with calcium, undiluted
Ribena light; low sugar, undiluted
Baby Ribena; blackcurrant
Ribena light, ready made
Ribena; all (other) types ready made
Lucozade light
Shloer, sparkling apple juice
Shloer, sparkling grape juice
Pineapple in natural juice
Peaches/pears/fruit cocktail in natural juice
Mandarins/strawberries/raspberries in natural juice
Mini snowballs
After eight mints
Kit-kat
Smarties
Tooty fruites/jelly tots
Angel delight/sugar free/ made with full-fat milk
Marshmallows
Crusha syrup
Iced magic
Potato croquettes; fried
Potato croquettes; grilled/baked
Pot Noodle/Super noodles.
60% polyunsaturated fat spread; Mellow, Vitalite light
60% mixed fat spread; Stork light
72% mixed fat spread; Golden Churn, Kraft, Clover Banquet, Summer County.
Low fat spread; polyunsaturated
St. Ivel lowest.
Low fat crisps

RECIPES.

Cheesey macaroni mince
Chicken fried rice
Stir-fry marrow
Noodle and turkey stir fry
Lentil lasagne
Beef goulash
Pasta with vegetables
Chicken and rice soup
Homemade lentil soup
Homemade broth
Potato and leek soup
Carrot and orange soup
Lasagne
Chicken in white sauce
Coleslaw made with mayonnaise
Chicken and pineapple
Stir-fry pork
Stir-fry pork with pineapple
Sausage casserole with veg
Lamb loin chops with barbeque sauce

RECIPES.

Egg sandwich filling
French toast
Liver pate
Lentil and tomato stew
Fish in breadcrumbs, fried in sunflower oil
Cheese straws
Pancakes

RECIPES.

Jelly whip with mandarins
Fresh fruit salad
Chocolate fudge cake
Peppermint slice
Banana bread
Homemade chocolate biscuits

CODING SCHEDULE FOR QUESTIONNAIRE.

Question Number	Coding schedule.
2a	Mothers social class: 1 = I, 2 = II, 3 = III non-manual = 3, 9 = III manual, 4 = IV, 5 = V
2b	Whether mother works: 1 = Full-time 2 = Part-time 3 = not-emplyment
3a	Fathers social class: As for mother, plus 6 = unemployed 7 = single unmarried mother 8 = single divorced mother
3b	Profession of unemployed fathers: as for 2a, 0 = not relevant.
5a/b	Nationality of father/mother: 1 British; 2 Indian/Pakistani; 3 Chinese/Eastern; 4 American/Canadian; 5 Other European; 6 Middle Eastern
6a	Whether following a special diet: 1 Yes; 2 No
6b	Type of special diet: 1 Lactovegetarian; 2 Vegan; 3 Moslem; 4 Kosher; 5 Other
7a-c	Frequency of use of table/family eating together/watching television at mealtimes: 0 Mealtimes occasionally; 1 Breakfast only 2 Lunch and breakfast only; 3 Dinner (tea) only 4 Breakfast and tea; 5 Lunch and tea 6 All; 7 Snacks only 8 Lunch only; 9 None
8a	Ability to use cutlery: 1 Spoon; 2 Spoon and fork 3 Knife and fork; 4 Tries knife and fork
8b	Preferred cutlery: 1 Fingers; 2 Fingers and spoon 3 Spoon alone; 4 Spoon and fork 5 Fork alone; 6 Knife and fork 7 Fingers and fork; 8 Varies
9a	Mothers response to food refusal: 1 Give something else; 2 Give no alternative 3 Coax to eat; 4 Situation rare 5 Response varies
9b	Whether child is spoon-fed if eating slowly: 1 Yes; 2 No; 3 Sometimes
10	Whether child eats food prepared for the family: 1 For the children (adults eat separately prepared food) 2 Yes, eats meals prepared for whole family 3 Tends to eat separately prepared food 4 Half occasions family meals, remainder separate
11	Classification of appetite: 1 Good appetite, not fussy 2 Good appetite, fussy 3 Appetite varies, not fussy 4 Appetite varies, fussy 5 Poor appetite, not fussy 6 Poor appetite, mother familiar with likes and dislikes 7 Poor appetite, fussy eater.

12a,b	Ability to use cup and preference of type:		
		1 Feeder with spout	2 Plastic cup
		3 Adult cup	4 Plastic tumbler
		5 All types	6 Bottle
		7 Feeder + plastic cup	8 Feeder + tumbler
		9 Type varies	
13a	Whether fluoride is given to child:		
		1 Yes 2 No	3 Sometimes
13b	Type of fluoride preparation:		
		1 DOH drops	2 DOH tablets
		3 Commercial types	0 Not relevant
14a	Whether child uses a fluoride toothpaste:		
		1 Yes 2 No	3 Sometimes
14bi	Whether child cleans teeth daily:		
		1 Yes 2 No	
14bii	The number of times teeth are cleaned daily:		
		Code = the number answered	
14biii	When teeth are usually cleaned:		
		1 Breakfast (BK) only	2 Lunchtime (L) only
		3 Bedtime (BD) only	4 Breakfast + bedtime
		5 BK + L + BD	6 L + BT
		7 BK + L	8 Varies
14c	Who usually cleans childs teeth:		
		1 Mother/father (if at least once daily)	
		2 Child alone	
		3 Joint effort by child and parent	
15ai	Whether child has visited a dentist:		
		1 Yes 2 No	
15aii	Number of previous visits to dentist:		
		Code = number answered	
		9 = several	
15aiii	Time interval between dental visits (months)		
		Code = number answered	
15bi	Whether child has received dental treatment:		
		1 Yes 2 No	
15bii	Type of dental treatment:		
		0 = No treatment	
		1 - 4 = number of fillings	
		5 = 5 or more fillings	
		6 = special treatments (of decayed teeth)	
		7 = extractions	
		8 = accidental damage	
		9 = decay due to poor health/illness	
16a	Whether a vitamin supplement is taken:		
		1 Yes 2 No	
		3 Sometimes 4 Winter only	

16b Type of vitamin preparation used:

0 Not relevant
1 DOH vitamin drops
2 Commercial type (type recorded)

17a Whether child suffers from a food allergy or intolerance:

1 Yes 2 No 3 Possibly

17b Type of food to which child is allergic:

Coded as food reference codes in McCance and Widdowson, The Composition of Foods. In addition, No. 970 = Azo dyes.

17c Symptoms of food allergy:

0 Not relevant
1 Urticarial rash
2 Eczema
3 Hyperactivity
4 Asthma
5 Vomiting/nausea
6 Watery eyes/runny nose
7 Diarrhoea

17d Whether allergy was diagnosed by the childs General Practitioner.

1 Yes 2 No 0 Not relevant

17e Action taken regarding allergy:

1 Self-mediated avoidance of foods
2 Cut-down intake of offending food
3 Advice received from dietitian
4 Advice received from doctor or health visitor
5 Homeopathic remedy/advice
6 Other
0 Not relevant

18a Usual number of stools per day:

1 More than one
2 Once daily
3 Every two or three days
4 Once weekly
5 Don't know

18b Whether child suffers from constipation:

1 Yes 2 No 3 Sometimes

18c Usual treatment for constipation:

0 Not relevant
1 High fibre diet
2 "Prunes occasionally" approach
3 Mild laxative eg syrup of figs
4 Stronger laxative
5 Hot bath
6 None
7 More fluids

19a Whether child has a regular bedtime:

1 Yes 2 No

19b Whether child wakes frequently at night:

1 Yes 2 No 3 Sometimes

19c Nature of sleeping difficulty, if any:

0 None
1 Light sleeper
2 Difficulty going to sleep
3 Waking and crying
4 Nightmares

20 Observed behaviour of child:

1 Quiet
2 Lively/not hyperative
2 Lively/possibly hyperative
3 Unruly

21	Mothers categorisation of childs behaviour:	
		1 Quiet and well-behaved (good) 2 Quiet but unattentive/disobedient 3 Lively but well behaved/good 4 Lively and unattentive/disobedient 5 Behaviour varies
22a-e	Factors influencing mothers choice of foods:	
		1 Frequently 2 Rarely 3 Sometimes
23	Food frequency:	
		1 = Daily 2 = 4-5 times weekly 3 = 2-3 times weekly 4 Once weekly 5 Fortnightly 6 Monthly 7 Occasionally 8 In season 9 Never
	Type of chips:	1 Cooked in oil 2 Cooked in animal fat 3 Oven chips 4 Varies 5 Chip-shop chips
24ai	Reason for choice of milk type:	
		0 Very little used so type irrelevant 1 Habit 2 Mother/family prefers taste of type used 3 Child prefers taste of type used 4 Mixture of types used 5 Low fat used as thought healthier 6 Full-fat used as thought healthier 7 Skimmed used as lower in calories 8 Convenient/easily purchased - give all family same type 9 Cost - use cheapest type available
24aii	Reason for use of spread:	
		0 Very little used 1 Habit - have always used same type 2 Spreads easily 3 Prefer taste of type used 4 Mixture of types used 5 Low fat spread used as thought healthier 6 Polyunsaturated fat margarine as thought healthier 7 Butter preferred as 'natural' 8 Convenience - readily available 9 Inexpensive
24bi	Whether same type of milk has been taken by child for past 12 months:	
		0 Very little milk used 1 Yes - full-fat used 2 No - type of milk changed 3 Yes - semi-skimmed milk 4 Mixture of types used 9 Uses Wysoy
24bii	Length of time FAMILY have been using type of milk :	
		0 Very little milk used, therefore insignificant. 1 - 5 Number of years semi-skimmed milk in use (5 = 5+) 6 Changed to semi-skimmed within pervious year 7 Changed from semi-skimmed to full-fat 8 Mixture of milks used 9 Always used full-fat
25a-c	Use of salt:	1 Yes 2 No 3 Sometimes

APPENDIX 4

PUBLICATIONS and PRESENTATIONS

Contents

Nutrition of the pre-school child: the media effect. Edinburgh Medicine 51, May 1988.

What should little children eat? University of Edinburgh Bulletin, October 1988.

Which scales? British Dietetic Association Adviser, Spring 1989.

Does a low fat diet impair growth in pre-school children? The Nutrition Society, Golden Jubilee Symposium, Cambridge. July 1991.

(Forthcoming publication in the Proceedings of the Nutrition Society).

The effect of variation in sources of energy intake on the nutritional quality of the diet of pre-school children. The Nutrition Society Annual Symposium, Edinburgh, 1991.

(Forthcoming publication in the Proceedings of the Nutrition Society).

Sugar intake and sources of sugar in the diet of pre-school children. The Nutrition Society Annual Symposium, Edinburgh, 1991.

(Forthcoming publication in the Proceedings of the Nutrition Society).

Should semi-skimmed milk be used in the diet of pre-school children? The European Society of Pediatric Research Annual Meeting, Zurich, September 1991.

(Forthcoming publication in Pediatric Research).

Nutrition of the pre-school child —

The media effect

by Anne Payne

Not so long ago written articles on nutrition only occasionally reached our local newspapers, today they merit front page status on the Sunday Times. (Sunday Times, May 22nd 1988). The British public are indeed taking the subject of nutrition in health and disease to heart.

Following the publication of the James (NACNE) report in 1983 and the COMA Report of 1984 there has been an ever increasing momentum towards change in the British diet. Both reports highlight the unhealthy nature of the British adult diet, in the light of recent medical evidence relating in particular to heart disease, obesity and bowel disorders. Since then the vigorous promotion of a "Healthy Diet", (ie less saturated fat, sugar and salt; with an increase in fibre and a slight increase in polyunsaturated fats), by health professionals, has attracted a great deal of media and therefore public attention.

Though the guidelines resulting from the above two reports were never intended for young children, a point stressed in the COMA report, children are inevitably taking the same "healthy" diet as their parents, and indeed are being encouraged to do so by many health professionals, particularly those whose interest is in the prevention of future coronary heart disease. However, some believe that very low fat/high fibre diets are inappropriate for young children due to the low energy density of such diets, particularly if intakes of whole milk are reduced, or replaced with skimmed or semi-skimmed milk. (Francis, 1986). The tag "meusli children" has recently been adopted in reference to "at risk" children in whom growth may be impaired.

This controversy concerning the nutritional requirements of pre-school children and the composition of their diet has resulted in media borne messages that, unfortunately, for both parents and health professionals alike are at best confusing and often quite contradictory. (Daily Telegraph, May 12th 1988; Scotsman, May 16th 1988.)

The essential question is how early in childhood should diets, designed to reduce morbidity and mortality in adulthood, be instituted?

Central to this issue is whether modification of diet in early childhood, aimed at preventing such conditions as cardiovascular disease and intestinal disease in adulthood, affects the normal growth and general health of pre-school children?

Energy, fibre, fat and fatty acid intakes are of particular significance with respect to growth requirements and the influence of these nutrients on the future development of cardiovascular and intestinal disease.

However, on reviewing the published nutritional literature it is evident that very little scientific data is available for the British pre-school child, aged two to five years, with which to substantiate nutritional policies of any kind.

The nutritional requirements of pre-school British children were first investigated by Widdowson in 1947. However, only energy was calculated and no anthropometric studies were undertaken. Despite its simplicity, this study was of major significance and, until 1979, provided the information on which DHSS dietary guidelines supported by other early surveys on the energy requirements of pre-school children. (Bransby and Fothergill, 1954; Ministry of Health, 1968).

In 1975 the DHSS published a survey showing the energy intakes of healthy young children as being lower than previously measured. (DHSS 1975). These figures were supported in 1976 by Black *et al.* who conducted a semi-longitudinal study of pre-school children in the Newcastle area, undertaken between 1968 and 1971. This study is the most nutritionally comprehensive investigation of the diet of British pre-school children yet undertaken, though intakes of fibre and fatty acids were not calculated. However, it is on the basis of these two studies that the current DHSS Recommended daily allowance for energy in pre-school children is based. (DHSS 1985, revised).

Though the above studies are extremely important to our understanding of the nutritional requirements of pre-school children,

we must remember that types of food available, lifestyle and society's awareness of nutrition are very different today, over 15 years later.

Typical fibre intakes and fibre requirements for British pre-school children have not yet been established, though Burkitt et al. (1980) states that a careful balance is necessary between energy and fibre intakes to avoid extremes of under and over nutrition.

Controversy over requirements of energy, fat and fatty acids has initiated a semi-skimmed milk-v-whole milk vendetta within the field of nutrition and dietetics. Though many health professionals believe that milk fat is an important source of energy, others argue that children can obtain their energy requirements from sources other than fats, particularly animal fats. The view of the COMA panel on child nutrition (BDA Newsletter, March 1987), echoed in "Present day practice in infant feeding, third report" (HMSO 1988) is that:

"Where semi-skimmed milk is in general use in a home there are no strong objections to its progressive introduction from the age of two years provided the child's overall dietary intake is adequate. Wholly skimmed milk should not be introduced below the age of five years." (BDA Members Newsletter, March 1987)

Several nutritional studies have been undertaken outwith Britain. These largely formed the background to a comprehensive 1987 report from the British Dietetic Association called "Children's Diet and Change", which sough to clarify the effect of changing the diet of children under five along the lines recently suggested for adults. Of particular note is an Australian longitudinal study by Magerey and Boulton (1984).

This very comprehensive study does include information on fibre and Fatty Acid intakes, and so provides useful comparative material. However, as the authors say: "differences in available food, climate, activity patterns and ethnic cooking habits of Australian families makes it difficult to extrapolate from nutritional studies in the U.S.A. or Britain". (Magarey and Boulton 1984). It is now generally agreed that more research into the diets of British pre-school children is required.

At the Department of Child Life and Health, University of Edinburgh, we are currently undertaking a three year research project entitled "A Nutritional Study of Pre-school Children in Edinburgh". This research project commenced in October 1987 with a six month period of careful planning and preparation which is now followed by an 18 to 24 month period of data collection.

Approximately 200 children between the ages of two and five years from Currie/Balerno, Wester Hailes, Trinity and Leith, will be involved. Names have been selected at random from the Lothian Child Health Register and each child's GP will be informed prior to inviting the child and its mother to participate in the study.

For each child data will be collected in the form of a seven day weighed food intake, 24 hour food recall, comprehensive questionnaire and anthropometric measurements of height, weight, triceps and subscapular skinfold thicknesses and mid-arm and mid-calf circumferences. It is hoped that at least half of the children will repeat the exercise one year later to provide a measure of growth velocity.

Data collection is now well under way. We are delighted by the number of mothers responding to our letter of invitation to participate in the study, and also by the considerable amount of effort they are devoting to it.

Our study aims to provide data relating tc the qualitative and quantitive nature of the diet of pre-school children ande current patterns of eating behaviour, and correlate i with anthropometric data. The dietary information will be analysed using computerisec food tables. Though this is not an interventive study, it is hoped that data from group: of children fed contrasting stypes of diet: will be suitable for comparison.

In particular, we will look at the effect the predominant use of either semi-skimmed o full-fat milk has on children's nutrient re sults of anthropometric measurements, in cluding growth velocity. We will look a fibre intakes, the energy: the fibre ratio an correlate levels of fibre intakes with th children's reported bowel habits.

Other aspects being examined includ socio-economic influences on diet: the us of vitamin and fluoride supplements; and b means of a simple food frequency chart, comparison of the childs eating habits wit that of the family.

This research project has been partl funded by the British Heart Foundation an the Nutritional Consultative Panel. It ha been granted ethical approval from both th obstetric and paediatric ethical committe and the community medicine/general prac tice ethical committee.

The results of our study are scheduled fc publication by autumn 1990. On the basis c these results we intend to commence the e: sential task of formulating realistic dietar guidelines for the British pre-school child.

Anne Payne is a Researcher in the Depa. ment of Child Life and Health.

What should little children eat?

Anne Payne *(right)* of the Department of Child Life and Health at the University, writes on her work on child nutrition

Nutrition is becoming an increasingly popular topic of conversation. Glance through any newspaper and you will almost certainly find an article about food and health, very likely centred on the interests of children. In recent years there has indeed been considerable controversy over the nutritional needs of young children, in the light of the "healthy" low-fat, high-fibre diet that is now recommended for older children and adults. This, unfortunately, has led to the publication of many conflicting articles in newspapers and magazines causing a degree of confusion and alarm in parents (Daily Telegraph, 12 May 1988; Scotsman, 16 May 1988).

Early in 1987 my concern, as an experienced dietitian and mother, led me to investigate the relationship between diet, growth and health in young children. It was very soon evident that little relevant scientific evidence was available for the British pre-school child, aged two to five years, with which to substantiate nutritional advice of any kind. A view supported by Dr Neville Belton, Senior Lecturer in the Department of Child Life and Health. As a result, I am now undertaking a PhD in the Department of Child Life and Health, entitled "A Nutritional Study of Pre-school Children in Edinburgh". The aim of the study is to investigate whether modification of diet in early childhood, aimed at preventing such conditions as cardiovascular disease and intestinal disease in adulthood, affects the normal growth and health of pre-school children.

Over the past 15 years our perception of the role of nutrition in health and disease has greatly altered. From a state of complacency, in the knowledge that nutritional deficiency is rare in this country, we have developed a sense of urgency in our quest to explore and explain the complex relationships between diet, disease and the nature of foods. Thus many recent studies have investigated the relationship between diet and conditions such as coronary heart disease, cancer, bowel disorders and allergies.

Following an evaluation of the available evidence, a discussion paper called the James (NACNE) Report was published by the Health Education Council in 1983, suggesting that British people should eat less fat, particularly animal fat, less sugar and salt, and increase our intake of fibre. A DHSS report of 1984 also stressed the importance of reducing our fat intake. Since 1983 this "healthy" diet has been strongly advocated by health professionals and has attracted a great deal of media attention. The food industry, ever sensitive to market trends, reacted swiftly to produce a range of "low fat", "low sugar", "low salt" "high fibre" alternatives for the health-conscious consumer.

Though the guidelines resulting from the NACNE and COMA reports were never intended for young children, a point stressed in the COMA report, children are inevitably eating the same "healthy" diet as their parents, and indeed are being encouraged to do so by many health professionals, particularly those whose interest is in the prevention of future coronary heart disease. However, some believe that very low fat/high fibre diets are inappropriate for young children due to their low energy density, particularly if intakes of whole milk are reduced, or replaced with skimmed or semi-skimmed milk (Francis 1986). The tag "muesli children" is now often heard in reference to the "at risk" children in whom growth may be impaired.

Milk has traditionally been a major source of nourishment in the diet of young British children. Today many health professionals still maintain that children should drink whole milk until the age of five, as milk fat is an important source of energy. However, others argue that children can obtain their energy requirements from sources other than fats, particularly animal fats, so it is safe and appropriate for children over two years of age to drink semi-skimmed milk.

Though typical fibre intakes and fibre requirements for British pre-school children have not yet been established, Burkitt et al (1980) stated that a careful balance is necessary between energy and fibre intakes to avoid extremes of under and over nutrition.

Energy, fibre, fat and fatty acid intakes are therefore of particular significance with respect to growth requirements and the influence of these nutrients on the future development of cardiovascular disease and intestinal disease.

The diet of British pre-school children was first investigated by Widdowson, in 1947. Only energy intake was calculated and no measurements of growth were taken. However, this study provided the information on which DHSS dietary guidelines for energy were based until 1979.

The most comprehensive study of British pre-school children yet undertaken was by Black, Billewicz and Thomson, between 1968 and 1971 in the Newcastle area. Fibre and fatty acid intakes could not be calculated at that time, as information on the amount of these items in foods was not available.

Without up-to-date research that examines the effect diet has on the health and growth of young children, we are unable to resolve this issue. Whilst several interesting studies have been undertaken outwith Britain, it has to be remembered that different ethnic cooking methods, foods available, climate and activity patterns render it inappropriate to extrapolate from nutritional studies in Sweden, the USA and Australia.

My research degree with the Department of Child Life and Health commenced in October 1987. Approximately 200 children between the age of two and five from Edinburgh are involved. Approximately 100 children are repeating the study after an interval of one year. For each child mothers are asked to weigh all food and drink eaten over a period of seven full days. Growth measurements, such as height and weight, are taken and a comprehensive questionnaire completed. The questionnaire includes questions about the use of vitamin and fluoride supplements, bowel habits, general behaviour, eating habits and by use of a simple food frequency chart compares the child's food habits to that of the family.

The response by mothers to our letter of invitation to participate in the study has been extremely good and they are certainly devoting a considerable amount of effort to it. Data collection commenced in May 1988 and is scheduled for completion by December 1989. Analysis of the dietary data is already underway, using the most up-to-date nutrition analysis software available.

This study will look, in particular, at the effect the predominant use of either semi-skimmed or full-fat milk has on the children's energy and nutrient intakes and will relate this information to measures of growth. We will look at fibre intakes, the energy: fibre ratio and correlate levels of fibre intakes with children's reported bowel habits. Other aspects being examined include socio-economic influences on diet, dental habits and sugar intake, and use of vitamin and fluoride supplements.

The results of this study will be available for publication by autumn 1990. On the basis of these results, we intend to influence the formulation of realistic dietary guidelines for the British Pre-school child.

This research programme has been funded by the Nutritional Consultative Panel, and my post-graduate studies have been supported by the British Heart Foundation and the Carnegie Trust.

Anne Payne, BSc, SRD
(Post-graduate student).

WHICH SCALES?

A comparison of electronic digital scales

Anne Payne, Edinburgh

ELECTRONIC digital scales have been on the market for several years, though in recent months there has been a rapid increase in the range of makes available.

Digital scales are generally more accurate, weigh in smaller units and are easier to read than spring balance scales. However, their characteristics vary from model to model, as does the price. It cannot be said that one scale is necessarily "better" than another as our requirements may also be very different. The needs of a dietary survey, for instance, are perhaps different from that of a diet bay or domestic kitchen.

Table 1 summaries the characteristics of a variety of digital scales currently available.

Points of consideration

Weighing Limit

The maximum weight capacity of scales varies from 1kg to 5kg. Scales with a low weight capacity may not be adequate if food is weighed on a heavy plate or in a large mixing bowl.

Weighing Unit: "Suggested" suitability

5 — 10g For domestic use.
2 — 5g Special diets.
1g Nutrition and dietetic research.

The Switches

Scales with separate On and Off switches are generally simpler to use then those with a one button operation, though if the switches are small and close together the elderly may have difficulty in using them.

Most scales available in Britain can weigh in either Imperial or Metric units. The position of the interchange switch is of relevance. If scales are to be used by a patient or research subject it is usually preferable that the switch is located unobtrusively on the base of the scale to avoid accidentally changing the weighing unit.

Auto switch — off time

This aims to conserve batteries. However, some scales switch off so rapidly that it can be confusing and incredibly irritating.

Tare facility

All of the digital scales surveyed had a tare facility. This allows the weight display to be set to zero, though items previously weighed remain on the scale.

Mains point

Batteries can be a source of considerable expense if a scale is in frequent use, so use of a mains lead is more economical. However, re-chargeable batteries have been found to be a relatively inexpensive compromise for scales that don't have a mains point.

Battery charger

If re-chargeable batteries are used, a battery charger is needed, costing £10-£15. Slow chargers (10-14 hours) preserve the life of the batteries better than rapid chargers (6 hours). Many battery chargers only hold 4 x 1.5v batteries, however, the Ever-Ready charger does hold a full 6 x 1.5v set of batteries.

Scale size

The current trend in digital scales is for a small compact base, often without a weighing vessel, intended for use with household plates and bowls. Unfortunately, many scales are so small that it is difficult to read the weight display when a large object, such as a plate, is placed on top. If necessary, this can be overcome using, for example, a non-slip baby bowl to form a raised base.

Durability

For most dietetic purposes it is important that the scales are fairly sturdy.

Special Features:

Some scales have special features that could be either useful or superfluous depending on your needs. Of the scales surveyed, the Avery scale is unusual in that it has a facility to allow you to calculate the energy, fat, carbohydrate and fibre content of the portion of food being weighed. To some this feature may be invaluable, to others it simply adds further confusion.

Accuracy

The scales were tested, usually at the retail outlet, using a set of test weights weighing 100g, 200g, 500g and 1000g. It should be noted that in each case only one set of scales, selected at random, was tested. The results, as given in Table 2, serve simply to highlight the importance of testing the accuracy of scales before purchase, to ensure that they are suitably accurate for your purpose.

The term "uneven load cell" means that when a weight is placed alternately on different sides of the weighing platform, different readings are

Continued on Page 37

obtained. This effect was found to be quite marked in both the "Hanson" and "Boot's Digital" scales.

To Conclude

This survey of scales was part of the preparatory work for a dietary survey entitled "A Nutritional Study of pre-school children in Edinburgh", that I am undertaking for a PhD in the Department of Child Life and Health, University of Edinburgh.

TABLE OF SCALES

TABLE 1

CHARACTERISTICS	TEFAL MICROTOUCH	BOOT'S DIGITAL	AVERY ELECTRONIC	EKS 5005	SOEHNLE (WHITE)	SOEHNLE B 8000	SOEHNLE B 8000/12
WEIGHT LIMIT (g)	4000	5000	5000	5000	2000	1000	3000
WEIGHING UNIT(g)	1g	5g	5g	5 to 1250 then 10g	2 to 126 then 5g	1 to 64 then 2g	2 to 126 then 5g
Separate on/off buttons?	No	Yes	Yes	Yes	No	No	No
Ease of use	Fair	Fair	Confusing	Good	Poor	Poor	Poor
Switch g ↔ oz? " location	Yes Base	Yes Top	Yes Top	Yes Top	Yes Base	Yes Base	Yes Base
Auto switch off? " " time?	Yes 3 minutes	Yes 2 min	* *	Yes 2 min	Yes 20 sec.	Yes 20 sec.	Yes 20 sec.
Tare facility?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mains point?	No	No	No	No	Yes	Yes	Yes
Battery type	1 x 9v	1 x 9v	1 x 9v	1 x 9v	6 x 1.5v	1 x 9v	1 x 9v
Scale bulk	Small	Medium	Medium	Large	Small	Medium	Medium
With bowl/jug?	No	Yes	Yes	Yes	No	Yes	Yes
Size of display	Medium	Small	Medium	Medium	Medium	Large	Large
Durability	Good	Fair	Good	Good	Fair	Fair	Fair
Approx. price	£35-£40 (ex. VAT)	£30 (inc. VAT)	£37 (Inc. VAT)	£31-£35 (inc. VAT)	£35 (inc. VAT)	£35 (inc. VAT)	£35 (inc. VAT)

CHARACTERISTICS	SALTER ELECTRONIC 5000	SALTER TRIMSCALE 2000	SALTER MICROTONIC	HANSON	WEDO ACCURAT 2000	WEDO ACCURAT 5000	WEDO DIGI 2000
WEIGHT LIMIT (g)	5000	2000	2000	2000	2000	5000	2000
WEIGHING UNIT(g)	5 to 320g then 10g	2 to 126g then 5g	2g	1g	1g	1g	1g
Separate on/off buttons?	No	No	No	Yes	Yes	Yes	Yes
Ease of use	Good	Poor	Fair	Good	V. good	V. good	V. good
Switch g ↔ oz? " location	Yes Base	Yes Base	Yes Top	Yes Top	Yes Top	Yes Top	Yes Top
Auto switch off? " " time?	Yes 20 sec.	Yes 20 sec.	Yes 60 sec.	Yes 5 mins.	No	No	Yes 1.5 minutes
Tare facility?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mains point?	Yes	Yes	No	Yes	Yes	Yes	Yes
Battery type	6 x 1.5v	6 x 1.5v	1 x 9v	6 x 1.5v	6 x 1.5v	6 x 1.5v	1 x 9v
Scale bulk	Large	Small	Small	Small	Small	Small	Small
With bowl/jug?	Yes	No	No	No	No	No	No
Size of display	Medium	Medium	Medium	Large	Small	Small	Medium
Durability	Good	Poor	Fair	Poor	V. Good	V. Good	V. Good
Approx. price	£35-£40 (inc. VAT)	£35-£40 (Inc. VAT)	£35-£40 (inc. VAT)	£25 (inc. VAT)	£99.50 (ex. VAT)	£169 (ex. VAT)	£75.50 (ex. VAT)

NOTE: *indicates unknown information.

Continued on Page 38

Continued from Page 37

My final choice of scale was the Tefal Microtouch, as it most closely fitted the specific requirements of the dietary survey. In this case it was necessary for the scale to weigh in a small unit, be accurate, compact for ease of transport, relatively easy to use and fairly sturdy. The cost, as ever, was an important consideration. Though a mains point would have been preferable, rechargeable batteries have been utilised very successfully.

Twenty sets of the Tefal scales have now been in constant use in the community over the past nine months. They have been readily accepted by mothers in the study (whose abilities vary considerably), and are proving both durable and reliable. ■

Useful Addresses

Salter Housewares Limited, 211 Vale Road, Tonbridge, Kent, TN9 1SU. Tel. (0732) 354828.

Paper, Chemical and General Ltd, Old Vicarage Drive, Appleby, Scunthorpe, South Humberside, DN15 0BY. Tel. (0724) 732101/734025.

Tefal U.K. Limited, Station Road, Langley, Slough, Berkshire, SL3 8DR.

TABLE 2 — WEIGHT TESTS

SCALE	WEIGHT READING AT CENTRE OF BALANCE 100g	200g	500g	1000g	WEIGHING UNIT
Salter Electronic	100	200	500	1000	5g to 320g then 10g
Salter Trimscale	*	*	*	*	2g to 126g then 5g
Salter Microtonic	100	200	500	1000	2g
Hanson	99	198	497	997	1g
Boots Digital	70	145	365	815	5g
Avery	*	*	*	*	5g
EKS 5005	95	200	500	1000	5 to 1250g then 10g
Soehnle (white)	100	200	500	1000	2g to 126g then 5g
Soehnle B 8000	106	210	524	OVERLOAD	1g to 64g then 2g
Soehnle B 8000/12	100	200	500	1000	2g to 126g then 5g
Wedo Accurat 2000	100	200	500	1000	1g
Wedo Accurat 5000	100	200	500	1000	1g
Wedo Digi	100	200	500	1000	1g
Tefal Microtouch	100	200	501	1002	1g

* Indicates sample unavailable to test.

Does a low-fat diet impair growth in pre-school children? By J. A. PAYNE[1], T. A. KIRK[2] and N. A. BELTON[1], [1]*Department of Child Life and Health, University of Edinburgh EH9 1UW* and [2]*Queen Margaret College, Edinburgh EH12 8TS*

There is controversy about whether recommendations to decrease the intake of fat in the UK diet to reduce heart disease should be applied to children under the age of 5 years. The prevailing view is one of caution in the application of such recommendations before the age of five due to concern that low fat intakes may impair growth and development (Department of Health and Social Security, 1988). However, there has been very little data on nutritional intake and growth parameters in this age group with which to make an informed judgement.

In the present study, energy and nutrient intakes were assessed in 153 children aged 2–5 years from Edinburgh using the 7-d weighed inventory method. Height, weight, mid-arm and mid-calf circumferences, and triceps and subscapular skinfold thicknesses were also measured and compared to current UK standards (Tanner *et al.* 1966*a*,*b*). Growth velocity data were obtained for a subset of fifty-four children from a 1-year follow-up study. Children with fat intakes below 30% energy from fat (group mean 27·7%, LF) were compared to those with fat intakes greater than 40% energy from fat (group mean 42·7%, HF). The Table shows that there are no significant differences in energy intakes or growth parameters between the groups, as assessed by independent *t* tests.

Comparison of energy intake and growth parameters

Group . . .	LF		HF		
Number . . .	20		23		
Male:female ratio . . .	11:9		10:13		
	Mean	SD	Mean	SD	
Energy (kcal)	1174	174	1192	269	NS
Age (months)	40	10	39	10	NS
Height (cm)	98·6	6·7	97·3	7·8	NS
Height percentile	65	30	68	22	NS
Weight (kg)	15·8	2·4	15·5	2·7	NS
Weight percentile	60	31	60	30	NS
Sub-scapular skinfold (mm)	5·8	1·5	5·7	1·3	NS
Triceps skinfold (mm)	9·7	1·9	9·3	1·9	NS

For the subset of children for whom growth velocity data were available there was no significant correlation with % energy from fat.

In conclusion, this study found no evidence to suggest that the growth of Edinburgh children taking a low-fat diet was compromised.

Department of Health and Social Security (1988). Present day Practice in Infant Feeding: Third Report. COMA Report on Health and Social Subjects No. 32. London: H.M. Stationery Office.

Tanner, T. M., Whitehouse, R. H. & Takaishi, M. (1966*a*). *Archives of Disease in Childhood* **41**, 454–471.

Tanner, T. M., Whitehouse, R. H. & Takaishi, M. (1966*b*). *Archives of Disease in Childhood* **41**, 613–635.

The effect of variation in sources of energy intake on the nutritional quality of the diet of pre-school children. By JESSICA A. PAYNE, *Department of Child Life and Health, University of Edinburgh EH9 1UW*

The suitability of modified diets for pre-school children, aimed at reducing morbidity and mortality in adulthood, is a controversial issue. Little information is available on the effect of modification of fat or sugar intake on the intake of energy and other nutrients.

Between May 1988 and April 1990, a total of 207 7 d weighed inventories were completed by pre-school children from Edinburgh aged 2–5 years. The effect of variation in sources of energy intake on the nutritional quality of the diet was assessed by correlating the percentage of energy (% En) from fat, sugar, and starch plus dextrin with total daily energy intake, and nutrient intake per 4·2 MJ (1000 kcal).

Using the Pearson correlation test, no significant correlation was found between total daily energy intake and % En from fat, sugar or starch plus dextrin.

A strong negative relationship of −0·62 (P<0·001) was found between % En from sugar and % En from fat.

% En from fat was negatively correlated (P<0·001) with intake of fibre, iron, thiamin, total folic acid, ascorbic acid and (P<0·01) pyridoxine, and positively correlated (P<0·001) with intake of protein, vitamin A and cyanocobalamin.

% En from sugar was negatively correlated (P<0·001) with intake of protein and (P<0·01) vitamin D, pyridoxine and cyanocobalamin, and positively correlated (P<0·001) with ascorbic acid, due to a strong relationship between sugar intake and fruit juice.

% En from starch plus dextrin was positively associated (P<0·001) with intake of fibre, Fe, thiamin, pyridoxine and total folic acid, and negatively correlated (P<0·001) with intake of calcium and (P<0·01) vitamin A.

In conclusion, the above results imply that the nutritional quality of the diet of pre-school children taking high fat or sugar intakes could be improved by encouraging a higher intake of starchy foods, whilst ensuring an adequate intake of Ca and vitamin A.

This study was supported by the British Heart Foundation and the Nutritional Consultative Panel.

Sugar intake and sources of sugar in the diet of pre-school children. By JESSICA A. PAYNE, *Department of Child Life and Health, University of Edinburgh, Edinburgh EH9 1UW*

The mean total sugar intake of UK adults aged 16–64 years was recently reported as being 19% of food energy intake (OPCS, 1990). Very little information is available on the total sugar intake of pre-school children though current policy is to recommend avoidance of food and drink rich in added sugars (DHSS, 1988).

By means of the 7 d weighed inventory technique, total sugar intake was assessed in children aged 2–5 years from Edinburgh.

	2 years		3 years		4 years	
Group	Mean	SD	Mean	SD	Mean	SD
Girls						
Number	42		38		30	
Age (months)	31	3	42	3	54	4
Energy intake (kJ/d)	4390	830	4757	715	5062	885
Sugar intake (g/d)	88	28	90	23	91	20
% Energy from sugar	31	6	30	6	29	7
Boys						
Number	31		31		35	
Age (months)	30	3	43	4	54	4
Energy intake (kJ/d)	4504	755	5008	888	5300	790
Sugar intake (g/d)	85	27	91	19	98	27
% Energy from sugar	30	7	29	5	29	6

Sources of sugar were examined in the diet of those children with an exceptionally high total sugar intake of 40%–53% of energy from sugar (*n* 10). The main sources of sugar were (mean values as % of total sugar intake): Ribena 20, pure fruit juice 18, chocolate 6, fresh fruit 5, fruit yoghurt 5, orange squash 5, other sweets 4. In individual children Ribena or pure fruit juice contributed up to 50% of sugar intake.

The study shows that young children tend to have a high sugar intake. Ribena and pure fruit juice were found to contribute to the exceptionally-high sugar intake of some children. This gives cause for concern as both drinks retain a 'healthy' image.

This study was supported by the British Heart Foundation and the Nutritional Consultative Panel.

Department of Health and Social Security (1988). *Present day practice in infant feeding: third report. COMA Report on Health and Social Subjects* no. 32. London: H.M. Stationery Office.

Office of Population Censuses and Surveys (1990). *The dietary and nutritional survey of British adults.* London: H.M. Stationery Office.

ABSTRACT

Deadline: Abstract must reach the address below before **April 15, 1991**

Do not fold! **Type abstract within box**

SHOULD SEMI-SKIMMED MILK BE RECOMMENDED FOR PRE-SCHOOL CHILDREN?

By Jessica A. Payne (spn. by Neil McIntosh), Department of Child Life and Health, University of Edinburgh, Edinburgh, Scotland.

In the U.K. caution is advised in giving semi-skimmed milk to pre-school children due to concern that low fat intakes may impair energy intake and growth. This study compares energy intake and growth in 120 children aged 2-4 years from Edinburgh, who had been taking either full-fat (4% fat) or semi-skimmed (2% fat) milk during the previous year. Nutrient intakes were assessed by the 7-day weighed method. Comparison is by independent t-tests.

Group	Full-fat Mean (SD)		Semi-skimmed Mean (SD)		
Number	95		25		
Age (months)	38	(10.5)	41.5	(11.0)	NS
Energy intake (kj/d)	4666	(875)	4948	(848)	NS
% Energy from fat	36.4	(4.6)	32.0	(4.8)	**
% Energy from starch	20.2	(4.7)	23.8	(3.9)	**
Height (cm)	96.3	(7.5)	99.3	(7.5)	NS
Weight (kg)	15.2	(2.4)	16.2	(2.5)	NS

NS = not significant ** = $P < 0.001$

Conclusion: Use of semi-skimmed milk does not impair energy intake or growth in pre-school children from Edinburgh, as energy intake is maintained by a higher intake of carbohydrate.

Please send the original and 1 xeroxcopy to:

Prof. G. Duc
Division of Neonatology
University Hospital of Zürich
Frauenklinikstrasse 10
CH-8091 Zürich/Switzerland
Tel. +41 1 255 53 40
Fax +41 1 255 44 42

Sponsor's name
Sponsor's signature

REFERENCES.

AMERICAN ACADEMY OF PEDIATRICS (1986) Prudent life-style for children: dietary fat and cholesterol. Pediatrics 78, 521-525.

ANDERSEN GE, LIFSCHITZ C, FRIIS-HANSEN B. (1979) Dietary habits and serum lipids during first 4 years of life; a study of 95 Danish children. Acta Paediatrica Scandinavica 68, 165-170.

ARMSTRONG N, BALDING J, GENTLE P, KIRKBY B. (1990) Patterns of physical activity among 11 to 16 year old British children. British Medical Journal 301, 203-205.

BARKER ME, McKENNA PG, REID NG, STRAIN JJ, THOMSON KA, WILLIAMSON AP, WRIGHT ME. (1988) A comparison of the Petra food recording system with the conventional weighed inventory technique. Journal of Human Nutrition and Dietetics 1, 179-188.

BENTON D, ROBERTS G. (1988) Effect of vitamin and mineral supplementation on intelligence of a sample of schoolchildren. Lancet, i, 140-143.

BINDRA G. (1985) Fibre and phytate. Nutrition and Food Science 95, 20-21.

BINGHAM SA, CUMMINGS JH, MURGATROYD PR. (1985) Petra: a new device for weighed dietary records. 13th Congress of Nutrition Book of Abstracts, Brighton, p 126.

BINGHAM S. (1987) The dietary assessment of individuals; methods, accuracy, new techniques and recommendations. Nutrition Abstracts and Reviews 57, 705-742.

BINGHAM SA. (1988) Methods for data collection at an individual level; weighed records. In: Cameron ME, Van Staveren WA (Editors) Manual on methodology for food consumption studies. Oxford University Press, Oxford, pp 55-63.

BIRCH LL, JOHNSON SL, ANDRESEN G, PETERS JC, SCHULTE MC. (1991) The variability of young children's energy intake. New England Journal of Medicine 324, 232-235.

BLACK AE, PAUL AA. (1987) A Cambrige mother and baby study on 39 three year old children from higher socioeconomic groups. In: National Dairy Council; Nutrition and children aged one to five. Fact file No.2. p13.

BLACK AE, RAVENSCROFT C, SIMS AJ. (1984) The NACNE report: are dietary goals realistic? Comparisons with the dietary patterns of dietitians. Human Nutrition: Applied Nutrition 38A, 165-179.

BLACK AE, BILLWICZ WZ, THOMSON AM. (1976) The diets of pre-school children in Newcastle upon Tyne 1968-1971. British Journal of Nutrition 35, 105-113.

BORRELLI R. (1990) Collection of food intake data: a reappraisal of criteria for judging the methods. British Journal of Nutrition 63, 411-417.

BOULTON J. (1981) Nutrition in childhood and its relation to early somatic growth, body fat, blood pressure and physical fitness. Acta Paediatrica Scandinavica Suppl. 284.

BRADLEY A, THEOBALD A. (1988) The effects of dietary modification as defined by NACNE on the eating habits of 28 people. Journal of Human Nutrition and Dietetics 1, 105-114.

BRANSBY ER, FOTHERGILL JE. (1954) The diets of young children. British Journal of Nutrition 8, 195-204.

BRITISH DIETETIC ASSOCIATION (1987) Children's diet and change. A report of the Child Health and Nutrition Working Party.

BRITISH DIETETIC ASSOCIATION (1985) Members newsletter - letters to the Editor, Jan - April.

BRITISH NUTRITION FOUNDATION (1990) Complex carbohydrates in food. Chapman and Hall, London.

BURKITT D, MORLEY D, WALKER A. (1980) Dietary fibre in under and over nutrition in childhood. Archives of Disease in Childhood 55, 803-807.

CADE JE, BOOTH S. (1990) What can people eat to meet the dietary guidelines and how much does it cost? Journal of Human Nutrition and Dietetics 3, 199-207.

CADE JE, MARGETTS BM. (1989) Dietary patterns in three English towns in relation to dietary goals and RDAs. Journal of Human Nutrition and Dietetics 2, 49-54.

CADE JE. (1988) Are diet records using household measures comparable to weighed intakes? Journal of Human Nutrition and Dietetics 1, 171-178.

CANT AJ. (1985) Food allergy in childhood. Human Nutrition: Applied Nutrition 39A, 277-293.

CHURCH MA. (1986) Nutrition education for children and adolescents in developed countries. Nutrition Education, 902-904.

CLARK J, COLE-HAMILTON I, GUNNER K, LEVERKUS C. (1984) Implementing the NACNE report. Human Nutrition: Applied Nutrition 38A, 164.

COHEN SA, HENDRICKS KM, MATHIS RK, LARAMEE S, WALKER WA. (1979) Chronic non-specific diarrhoea: Dietary relationships. Pediatrics 64, 402-407.

COLE-HAMILTON I, GUNNER K, LEVERKUS C, STARR J. (1986) A study among dietitians and adult members of their households of the practicalities and implications of following proposed dietary guidelines for the UK. Human Nutrition: Applied Nutrition 40A, 365-389.

COOK JD, BOTHWELL TH. (1984) Availabilty of iron from infant foods, pp 119-145. In: Stekel A. (Editor) Iron Nutrition in Infant Foods. Nestle, Vevey/Raven Press, New York.

CORONARY PREVENTION GROUP (1988) Children at risk: should prevention of coronary heart disease begin in childhood? A policy statement from the Scientific and Medical Advisory Committee, London.

COWARD WA. (1988) The doubly-labelled-water method: principles and practice. Proceedings of the Nutrition Society 47, 209-218.

CRAWLEY H. (1988) Food portion sizes. HMSO London.

CROMBIE IK, TODMAN J, McNEILL G, du V.FLOREY C, MENZIES I, KENNEDY RA. (1990) Effect of vitamin and mineral supplementation on verbal and non-verbal reasoning of schoolchildren. Lancet 335, 744-747.

DAVIS CM.(1938) The self-selection of diet experiments: its significance for feeding in the home. Ohio State Medical Journal 34, 862-868. As quoted by Storey M and Brown JE. (1987) Do young children instinctively know what to eat? New England Journal of Medicine 316, 103-106.

DAVIS PSW, LIVINGSTONE MBE, PRENTICE AM, COWARD WA, JAGGER SE, STEWART C, STRAIN JJ, WHITEHEAD RG. (1991) Total energy expenditure during childhood and adolescence. Proceedings of the Nutrition Society 50, 14A.

DECKELBAUM RJ. (1990) Nutrition, the child and atherosclerosis. Acta Paediatrica Scandinavica, Suppl. 365, 7-12.

DEPARTMENT OF HEALTH (1989a) Dietary sugars and human disease. Report on Health and Social Subjects No. 37. HMSO, London.

DEPARTMENT OF HEALTH (1989b) The diets of British schoolchildren. COMA Sub-Committee on Nutritional Surveillance. Report on Health and Social Subjects No. 36. HMSO, London.

DEPARTMENT OF HEALTH (1991) Dietary reference values for food energy and nutrients for the United Kingdom. Report on Health and Social Subjects No. 41. HMSO, London.

DEPARTMENT OF HEALTH AND SOCIAL SECURITY (1975) A nutrition survey of pre-school children 1967-1968. Report in Health and Social Subjects No.10. HMSO, London.

DEPARTMENT OF HEALTH AND SOCIAL SECURITY (1979) Recommended daily amounts of food energy and nutrients for groups of people in the United Kingdom. Report on Health and Social Subjects No. 15, HMSO, London.

DEPARTMENT OF HEALTH AND SOCIAL SECURITY (1984) Diet and cardiovascular disease. Committee on Medical Aspects of Food Policy. Reports on Health and Social Subjects No. 28, HMSO, London.

DEPARTMENT OF HEALTH AND SOCIAL SECURITY (1988) Present day practice in infant feeding; third report. Report on Health and Social Subjects No. 32. HMSO, London.

DICKERSON JWT, PEPLER F. (1980) Diet and Hyperactivity. Journal of Human Nutrition 34, 167-174.

DURNIN JVGA. (1988) Advice on low fat milk criticised. Scotsman May 16th, Edinburgh.

EDINGTON J, THOROGOOD M, GEEKIE M, BALL M, MANN J. (1989) Assessment of nutritional intake using dietary records with estimated weights. Journal of Human Nutrition and Dietetics 2, 407-414.

EGGER J, CARTER CM, GRAHAM PJ, GUMLEY D, SOOTHILL JF. (1985) Controlled trial of oligoantigenic treatment in the hyperkinetic syndrome. Lancet, i, 540-545.

ELWOOD PC, BIRD G. (1983) A photographic method of diet evaluation. Human Nutrition: Applied Nutrition 37A, 474-477.

EMERY PW, GEISSLER CG, JUDD PA. (1988) Vitamin/mineral supplementation and non-verbal intelligence. Lancet, i, 407.

ENOS W, HOLMES R, BEYER J. (1953) Coronary disease among United States soldiers killed in action in Korea. Journal of the American Medical Association 152, 1090-1092.

EPPRIGHT ES, FOX HM, FRYER BA. (1972) Nutrition of infants and pre-school children in the north central region of the USA. World Reviews of Nutrition and Dietetics 14, 269-332.

FEINGOLD BF. (1975) Hyperkinesis and learning disabilities linked to artificial food flavors and colors. American Journal of Clinical Nutrition 75, 797-803.

FJELD CR, SCHOELLER DA. (1988) Energy expenditure of malnourished children during catch-up growth. Proceedings of the Nutrition Society 47, 227-231.

FIELDHOUSE P. (1986) Food and nutrition: customs and culture. Crook Helm Ltd. Kent.

FOMON SJ, FILER LJ, ZIEGLAR EE, BERGMANN KE, BERGMANN RL. (1979) Skim milk in infant feeding. Acta Paediatrica Scandinavica 65, 17-30.

FORBES GB. (1991) Children and food - order amid chaos. New England Journal of Medicine 324, 262-263.

FORBES GB. (1977) Nutrition and growth. Journal of Pediatrics 91, 40-42.

FRANCESCATO MP, ZALATEO C, TONINI G, NORDIO S, de BERNARD B. (1990) Feeding practices of Italian children 8-36 months old. Journal of Human Nutrition and Dietetics 3, 273-281.

FRANCIS DEM. (1986) Nutrition for children. Blackwell Scientific Publications, Oxford.

FURNHAM A. (1991) Feed the minds. British Medical Journal 302, 598-599.

GEDDES DAM. (1991) Teeth for the future. Acta Paediatrica Scandinavica Supp. 373, 53-57.

GIBNEY MJ. (1990a) Dietary guidelines: a critical appraisal. Journal of Human Nutrition and Dietetics 3, 245-254.

GIBNEY M (1990b) A dietary dilemma - where next with fat and sugar? CHO International Dialogue on carbohydrate 1, 1-4.

GIBSON RS, HEYWOOD A, YAMAN C, SOHLSTROM A, THOMPSON LU, HEYWOOD P. (1991) Growth in children from the Wosera subdistrict, Papua New Guinea, in relation to energy and protein intakes and zinc status. American Journal of Clinical Nutrition 53, 782-789.

GRIFFITHS M, PAYNE PR, STUNKARD AJ, RIVERS JPW, COX M. (1990) Metabolic rate and physical development in children at risk of obesity. Lancet 336, 76-78.

GRIFFITHS M, RIVERS JPW, HOINVILLE EA. (1985) Obesity in boys: the distinction between fatness and heaviness. Human Nutrition: Clinical Nutrition 39C, 259-270.

GULLIFORD MC, CHINN S, RONA RJ. (1991) Social environment and height: England and Scotland 1987 and 1988. Archives of Disease in Childhood 66, 235-240.

HACKETT AF, JARVIS SN, MATTHEWS JNS. (1990) A study of the eating habits of 11 and 12 year old children before and one year after the start of a healthy eating campaign in Northumberland. Journal of Human Nutrition and Dietetics 3, 323-331.

HAGMAN U, BRUCE A, PERSSON LA, SAMUELSON G, SJOLIN S. (1986) Food habits and nutrient intake in childhood in relation to health and socio-economic conditions; a Swedish multicentre study 1980-1981. Acta Paediatrica Scandinavica, Suppl. 328.

HARALDSDOTTIR J. (1988) Methods for data collection at an individual level; dietary history. In: Cameron ME, Van Staveren WA (Editors) Manual on methodology for food consumption studies. Oxford University Press, Oxford, pp 88 - 92.

HARALDSDOTTIR J, VAN STAVEREN WA. (1988) Methods for data collection at an individual level; food frequency. In: Cameron ME, Van Staveren WA (Editors) Manual on methodology for food consumption studies. Oxford University Press, Oxford, pp 92 - 95.

HEPPINSTALL E, PUCKERING C, SKUSE D, START K, ZUR-SZPIRO S, DOWDNEY L. (1987) Nutrition and mealtime behaviour in families of growth-retarded children. Human Nutrition: Applied Nutrition 41A, 390-402.

HOFFMANS MDAF, OBERMANN-de-BOER GL, FLORACK EIM, van KAMPEN-DOKER M, KROMHOUT D. (1986) Energy, nutrient and food intake during infancy and early childhood. The Leiden pre-school children study. Human Nutrition: Applied Nutrition 40A, 421-430.

HOLLAND B, UNWIN ID, BUSS DH. (1989) Milk products and eggs. Fourth supplement to McCance and Widdowson's The Composition of Foods (4th Edition). MAFF and Royal Society of Chemistry, Cambridge.

HOLLAND B, UNWIN ID, BUSS DH. (1988) Cereal and cereal products. Third supplement to McCance and Widdowson's The Composition of Foods (4th Edition). MAFF and Royal Society of Chemistry, Nottingham.

JACKSON AA, WOOTTON SA. (1990) Accuracy of weighed dietary records. British Medical Journal 300, 1138-1139.

JACOBS C, DWYER JT. (1988) Vegetarian children: appropriate and inappropriate diets. American Journal of Clinical Nutrition 48, 811-818.

JAMES J, LAWSON P, MALE P, OAKHILL A. (1989) Preventing iron deficiency in preschool children by implementing an educational and screening programme in an inner city practice. British Medical Journal 299, 838-840.

JEQUIER E, SCHUTZ Y. (1988) Classical respirometry and the doubly-labelled-water method: appropriate applications of the individual or combined techniques. Proceedings of the Nutrition Society 47, 219-225.

KELNAR CJH (1989) Disorders of growth. Prescibers' Journal 29, 117-124.

KWTEROVICH PO. (1986) Biochemical, clinical, epidemiologic, genetic and parhologic data in the pediatric age group relevant to the cholesterol hypothesis. Pediatrics 78, 349-362.

LAUER RM, LEE J, CLARKE WR. (1988) Factors affecting the relationship between childhood and adult cholesterol levels: The Muscatine Study. Pediatrics 82, 309-318.

LENNON D, FIELDHOUSE P. (1982) Social nutrition. Forbes Publications, London.

LIFSHITZ F, MOSES N. (1989) A complication of dietary treatment of hypercholesterolemia. American Journal of Disease in Childhood 143, 537-542.

LIVINGSTONE MBE, PRENTICE AM, STRAIN JJ, COWARD WA, BLACK AE, BARKER ME, McKENNA PG, WHITEHEAD RG. (1990) Accuracy of weighed dietary records in studies of diet and health. British Medical Journal 300, 708-712.

LIVINGSTONE MBE, DAVIES PSW, PRENTICE AM, COWARD WA, BLACK AE, STRAIN JJ, McKENNA PG. (1991) Comparison of simultaneous measures of energy intake and expenditure in children and adolescents. Proceedings of the Nutrition Society 50, 15A.

LEVY J. (Ed. 1990) What is sugar? CHO International Dialogue on Carbohydrates 1, 2.

LLOYD JK. (1991) Cholesterol: Should we screen all children or change the diet of all children? Acta Paediatrica Scandinavica Supp. 373, 66-72.

LOKEN EB. (1988) Methods for data collection at an individual level; 24-hour recall. In: Cameron ME, Van Staveren WA (Editors) Manual on methodology for food consumption studies. Oxford University Press, Oxford, pp 83 - 88.

MAGAREY A, BOULTON TJC. (1984) Nutritional studies during childhood: IV energy and nutrient intake at age 4. Australian Paediatric Journal 20, 187-194.

MARR JW. (1971) Individual dietary surveys: purposes and methods. World Review of Nutrition and Dietetics 13, 106-164.

McNAMARA JJ, MOLOT MA, STREMPLE JF, CUTTING TR. (1971) Coronary artery disease in combat casualties in Vietnam. Journal of the American Medical Association 216, 1185-1187.

McNEILL G, DAVIDSON L, MORRISON DC, CROMBIE IK, KEIGHRAN J, TODMAN J. (1991) Nutrient intake in school children: some practical considerations. Proceedings of the Nutrition Society 50, 37-43.

MORGAN J. (1980) The dietary survey and the assessment of food intake in the pre-school child. A review. Journal of Human Nutrition 34, 376 - 381.

NAISMITH DJ, NELSON M, BURLEY VJ, GATENBY SJ. (1988) Can children's intelligence be increased by vitamin and mineral supplements? Lancet, 335.

NATIONAL ACADEMY OF SCIENCE (1989) Report on diet and health. Nutrition Reviews 47, 142-149.

NATIONAL ADVISORY COMMITTEE ON NUTRITION EDUCATION (1983) Proposals for national guidelines for health education in Britain. Health Education Council, London.

NCHS (1979) National Centre for Health Statistics growth charts - United States Department of Health Education and Welfare, Public Health Service, Health Resourses Administration, Rockville, Md., HRA 76 - 1120, 25, 3. Reproduced in: WHO (1979) Measurement of nutritional impact. WHO Geneva.

NATIONAL DAIRY COUNCIL (1987) Nutrition and children aged one to five. Fact file no.2. 11-17.

NATIONAL INSTITUTE OF HEALTH, CONCENSUS DEVELOPMENT PANEL (1985) Lowering blood cholesterol to prevent heart disease. Journal of the American Medical Association 253, 2080-2086.

NELSON M. (1991) Food, vitamins and IQ. Proceedings of the Nutrition Society 50, 29-35.

NELSON M, NAISMITH DJ, BURLEY V, GATENBY S, GEDDES N. (1990) Nutrient intakes, vitamin-mineral supplementation, and intelligence in British schoolchildren. British Journal of Nutrition 64, 13-22.

NELSON M. (1988) Methods for data collection at an individual level; estimated records. In: Cameron ME, Van Staveren WA (Editors) Manual on methodology for food consumption studies. Oxford University Press, Oxford, pp 64 - 75.

NELSON M. (1985) Nutritional goals from COMA and NACNE: how can they be acheived? Human Nutrition: Applied Nutrition 39A, 456-464.

NEWMAN WP, FREEDMAN DS, VOORS AW, GARD PD, SRINIVASAN SR, CRESANTA JL, WILLIAMSON GD, WEBBER LS, BERENSON GS. (1986) Relation of serum lipoprotein levels and systolic blood pressure to early atherosclerosis; The Bogalusa Heart Study. New England Journal of Medicine 314, 138-144.

NEWSON J, NEWSON E. (1968) Four year olds in an urban community. George Allen and Unwin, London pp 205 - 242.

NICKLAS TA, FARRIS RP, MAJOR C, FRANK GC, WEBBER LS, CRESANTA JL, BERENSON GS. (1987) Dietary intakes; The Bogalusa Heart Study. Pediatrics 80, 797-806.

O'CONNEL JM, DIBLEY MJ, SIERRA J, WALLACE B, MARKS JS, YIP R. (1989) Growth of vegetarian children: The Farm Study. Pediatrics 84, 475-481.

OFFICE OF POPULATION CENSUSES AND SURVEYS (1990) The dietary and nutritional survey of British adults. HMSO London.

PAUL AA, WHITEHEAD RG, BLACK AE. (1990) Energy intakes and growth from two months to three years in initially breast-fed children. Journal of Human Nutrition and Dietetics 3, 79-92.

PAUL AA, SOUTHGATE DAT. (1988) Methods for data collection at an individual level; conversion into nutrients. In: Cameron ME, Van Staveren WA (Editors) Manual on methodology for food consumption studies. Oxford University Press, Oxford, pp 121 - 144.

PAUL AA, SOUTHGATE DAT, RUSSELL J. (1980) First supplement to McCance and Widdowson's The Composition of Foods: Amino acid composition (mg per 100g food) and fatty acid composition (g per 100g food), HMSO, London.

PAUL AA, SOUTHGATE DAT. (1978) McCance and Widdowson's: The Composition of Foods; fourth edition. HMSO, London.

PARIZKOVA J, MACKOVA E, MACKOVA J, SKOPKOVA M. (1986) Blood lipids as related to food intake, body composition, and cardiorespiratory efficiency in pre-school children. Journal of Pediatric Gastroenterology and Nutrition 5, 295-298.

PATON DN, FINDLAY L. (1926) Poverty, nutrition and growth. Studies of child life in cities and rural districts of Scotland. MRC Special Report Series No. 101, HMSO, London.

POSKITT EME, COLE TJ, LAWSON DEM. (1979) Diet, sunlight, and 25-hydroxyvitamin D in healthy children and adults. British Medical Journal, 1, 221-223.

POSKITT EME. (1986) Obesity in th young child: whither and whence? Acta Paediatrica Scandinavica Suppl. 323, 24-32.

PRENTICE AM, LUCAS A, VASQUEZ-VELASQUEZ L, DAVIES PSW, WHITEHEAD RG. (1988) Are current dietary guidelines for young children a prescription for overfeeding? Lancet, ii, 1066-1069.

RALPH A, MASSIE L, McNEILL G, VINT H, JAMES WPT. (1990) Estimation of food and macronutrient intake by household measures. Journal of Human Nutrition and Dietetics 3, 39-46.

ROSHANAI F, SANDERS TAB. (1984) Assessment of fatty acid intake in vegans and omnivores. Human Nutrition: Applied Nutrition 38A, 345-354.

ROSSANDER L, HALLBERG L, BJORN-RASMUSSEN E. (1979) Absorption of iron from breakfast meals. American Journal of Clinical Nutrition 32, 2484-2489.

SABATE J, LINDSTED KD, HARRIS RD, JOHNSTON PK. (1990) Anthropometric parameters of schoolchildren with different life-styles. American Journal of Diseases in Childhood 144, 1159-1163.

SALMON J. (1991) Dietary reference values; a guide. HMSO, London.

SANDERS TAB. (1988) Growth and development of British vegan children. American Journal of Clinical Nutrition 48, 822-825.

SANDERS TAB, PURVES R. (1981) An anthropometric and dietary assessment of the nutritional status of vegan pre-school children. Journal of Human Nutrition 35, 349-357.

SCHOENTHALER SJ, AMOS SP, EYSENECK HJ, PERITZ E, YUDKIN J. (1991) Controlled trial of vitamin-mineral supplementation: effects on intelligence and performance. Personality and Individual Development 12, 351-362.

SIGMAN M, NEUMANN C, BAKSH M, BWIBO N, McDONALD MA. (1989) Nutrition and development in Kenyan toddlers. Journal of Pediatrics 115, 357-364.

SKUSE DH. (1989) Emotional abuse and delay in growth. British Medical Journal 299, 113-115.

SMITH DE, BOOTH IW. (1989) Nutritional assessment of children: guidelines on collecting and interpreting anthropometric data. Journal of Human Nutrition and Dietetics 2, 217-224.

STOCKLEY L. (1988) Food composition tables in the calculation of the nutrient content of mixed diets. Journal of Human Nutrition and Dietetics 1, 187-198.

STOCKLEY L, CHAPMAN RI, HOLLEY ML, JONES FA, PRESCOTT EHA, BROADHURST AJ. (1986a) Description of a food recording electronic device for use in dietary surveys. Human Nutrition: Applied Nutrition 40A, 13-18.

STOCKLEY L, HURREN CA, CHAPMAN RI, BROADHURST AJ, JONES FA. (1986b) Energy, protein and fat intake estimated using a food recording electronic device compared with a weighed diary. Human Nutrition: Applied Nutrition 40A, 19-23.

STOCKLEY L, FAULKS RM, BROADHURST AJ, GREATOREX EA, NELSON M. (1985) An abbreviated food table using food groups for the calculation of energy, protein and fat intake. Human Nutrition: Applied Nutrition 39A, 339-348.

STOREY M, BROWN JE. (1987) Do young children instinctively know what to eat? New England Journal of Medicine 316, 103-106.

TAITZ LS. (1987) Diet of young children and cardiovascular disease. British Medical Journal 294, 920.

TAN SP, WENLOCK RW, BUSS DH. (1985) Second supplement to McCance and Widdowson's The Composition of Foods: Immigrant foods. HMSO, London.

TANNER JM. (1989) Foetus into man; physical growth from conception to maturity. Castlemead Publications, Ware.

TANNER JM, DAVIES PSW. (1985) Clinical longitudinal standards for height and height velocity for North American Children. Journal of Pediatrics 107, 317-329.

TANNER JM, WHITEHOUSE RH. (1975) Revised standards for triceps and sub-scapular skinfolds in British children. Archives of Disease in Childhood 50, 142-145.

TANNER JM, WHITEHOUSE RH, TAKAISHI M. (1966) Standards from birth to maturity for height, weight, height velocity and weight velocity; British children 1965. Archives of Disease in childhood 41, 454-471; 613-635.

THOMAS B. (1988) (Editor) Manual of dietetic practice. Blackwell Scientific Publications, Oxford.

VAN-STAVEREN WA, DAGNELIE PC. (1988) Food consumption, growth, and development of Dutch children fed on alternative diets. American Journal of Clinical Nutrition 48, 819-821.

VASQUEZ-VELASQUEZ L. (1988) Energy expenditure and physical activity of malnourished Gambian infants. Proceedings of the Nutrition Society 47, 233-239.

WARWICK PM, WILLIAMS LT. (1987) Dietary intake of individuals interested in eating a healthy diet: a validation study of intake before and after dietary advice. Human Nutrition: Applied Nutrition 41A, 409-425.

WATERLOW JC, PAYNE PR. (1975) The protein gap. Nature 258, 113-117.

WEIDMAN W, KWITEROVICH P, JESSE MJ (1983) Diet in the healthy child. Circulation 67, 1411A-1414A.

WIDDOWSON EM. (1947) A study of individual children's diets. MRC Special Report Series No. 257. HMSO, London.

WILES SJ, NETTLETON PA, BLACK AE, PAUL AA. (1980) The nutrient composition of some cooked dishes eaten in Britain: a supplementary food composition table. Journal of Human Nutrition 34, 189-223.

WHITEHEAD RG. (1991) Vitamins, mineral schoolchildren, and IQ: More questions than answers (still). British Medical Journal 302, 548.

WHITEHEAD RG. (1981) Dietary goals - past and present. Royal Society of Health 2, 58-62.

WORLD HEALTH ORGANISATION (1979) Measurement of nutritional impact. WHO Geneva.

WRIGHT P. (1991) Development of food choice during infancy. Proceedings of the Nutrition Society 50, 107-113.

YEUNG DL, PENNEL MD, LEUNG M, HALL J. (1982) The effect of 2% milk intake on infant nutrition. Nutrition Research 2, 651-660.

ZIGLIO E. (1986) 'Uncertainty' in health promotion: nutrition policy in two countries. Health Promotion 1, 257-268.